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THE UNIVERSITY OF ALBERTA

THE GEOLOGY AND URANIUM DEPOSITS
OF PROTEROZOIC ROCKS, SIMPSON ISLANDS,
NORTHWEST TERRITORIES

by

© Richard R. Walker

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH
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ABSTRACT

This study documents the geology and uranium deposits within an area of Aphebian arenites located on Simpson Islands in the East Arm of Great Slave Lake, N.W.T. The area is underlain principally by fluvial, conglomeratic subarkose of the Hornby Channel Formation which was deposited upon a paleoregolith developed on Archean granitic and high-grade metamorphic basement rocks.

The geological evolution of the East Arm structural trough was profoundly influenced by the controlling McDonald fault system. This essentially transcurrent fault zone was active prior to deposition of early Aphebian sediments. Penecontemporaneous deformation features and rapid lateral facies variations in the Simpson Islands area suggest that fault movement during deposition of the Hornby Channel Formation was transcurrent.

Volcaniclastic rocks and air fall tuffs occur locally in the Hornby Channel Formation. Metamorphic mineralogy of one volcaniclastic rock type indicates the Hornby Channel Formation was subjected to prehnite-pumpellyite-quartz facies burial metamorphism.

A large albite syenite dyke was intruded along faults of the Simpson Islands fault system after deposition of the Hornby Channel Formation. Two K-Ar isotopic dates of this dyke indicate an age of approximately 2185 million years. A bostonite stock intruded the Hornby Channel Formation close to the petrologically similar albite syenite dyke. The bostonite is spatially and probably genetically related to diatremes which postdate the bostonite. The complex system of diatremes which intruded the Hornby Channel Formation along the Simpson Islands fault system are representatives of more widespread, fault-controlled diatreme activity.

The diatremes originate in the Archean basement, cut the Hornby Channel Formation and involve sedimentary rocks from at least one other formation. The diatreme breccias are highly variable and are associated with extensive in situ brecciation of adjacent sandstone which was also intruded by breccia dykes. Development of the diatremes involved explosive activity, fluidization processes and possibly hydraulic fracturing. Extensive albitization affected comminuted quartzo-feldspathic breccia matrix and sandstone adjacent diatremes. Sandstones within a couple of thousand feet of major McDonald system faults show evidence of widespread silicification and albitization.

Uranium deposits in the thesis area occur in sandstones at various stratigraphic levels within the Hornby Channel Formation. Reduced uranium mineralization is characterized by interstitial, very fine-grained pyrite and uraninite within grey to black sandstone. Uraninite occurs in various states of oxidation and has commonly been altered to amorphous coffinite. Minor chalcopyrite and galena are commonly present as well as traces of cobaltite, arsenopyrite, hematite, anatase and covellite. Uranium content commonly ranges from 0.5 to 1.5% U_3O_8. The reduced uranium mineralization is epigenetic, has a patchy distribution, and is associated with morphologically similar patches of red hematized sandstone. Oxidized uranium mineralization is characterized by secondary uranyl salts which occur interstitially and coat joints in both red (hematized) and buff-colored sandstones.

The Simpson Islands uranium deposits may have been formed by groundwater processes in a manner analogous to the epigenetic sandstone type deposits of Wyoming or the Colorado Plateau. This mineralization may have occurred during the erosional hiatus represented by the unconformity

at the base of the Et-then Group about 1750 m.y. ago when the Hornby Channel Formation in the Simpson Islands area was exposed to subaerial weathering conditions.

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CHAPTER I

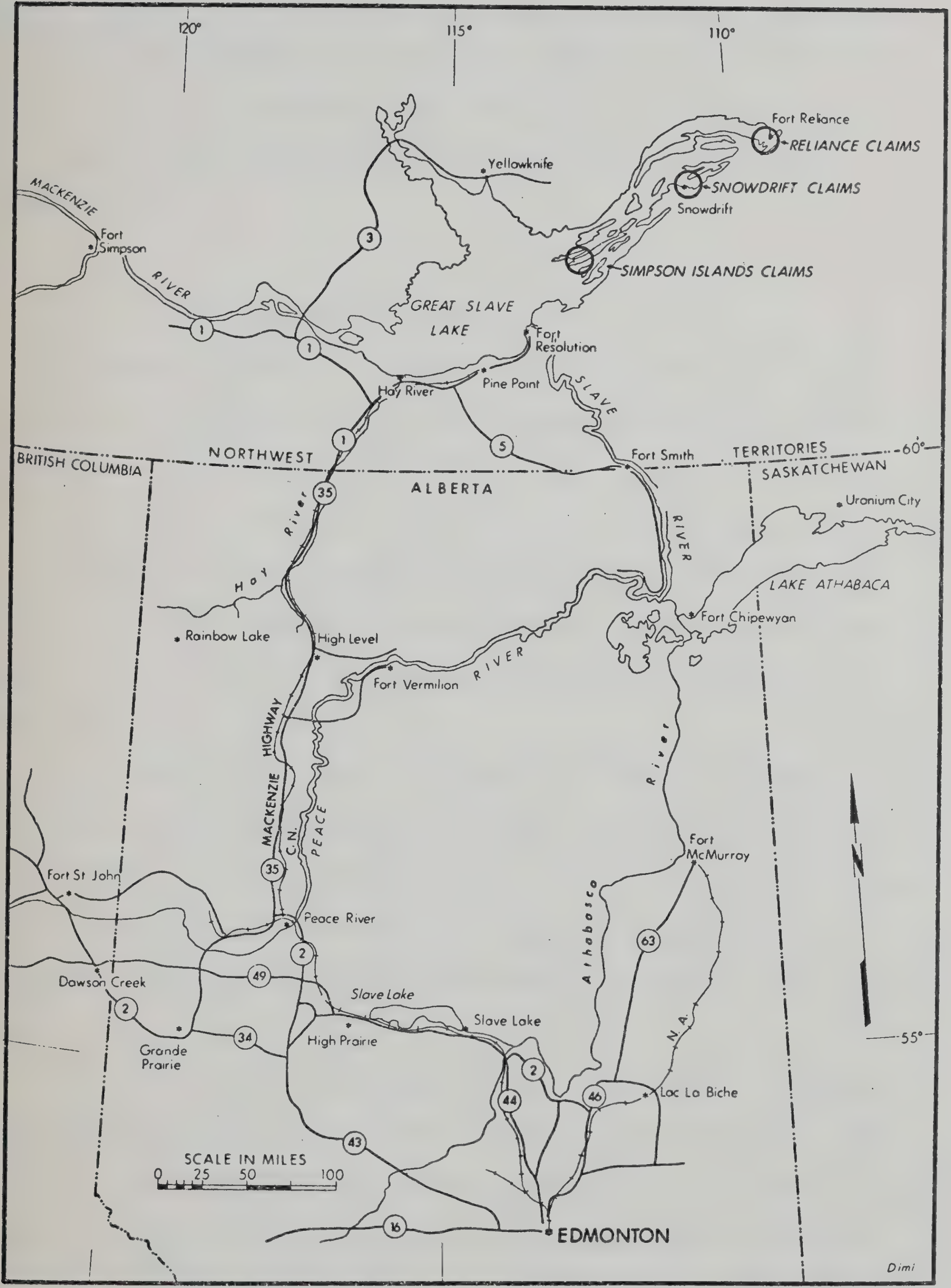
INTRODUCTION

General

In the fall of 1969, Vestor Explorations Ltd. investigated an occurrence of uranium mineralization in Aphebian sandstones of the Hornby Channel Formation in the Simpson Islands area of the East Arm of Great Slave Lake, N.W.T. Over the subsequent two years the Company conducted extensive exploration, including about 9000 feet of diamond drilling, on a block of some 570 mining claims in the Simpson Islands area. Concurrently regional and detailed uranium exploration was conducted in Sosan-Group strata throughout the East Arm of Great Slave Lake.

During the summers of 1970 and 1971 (totaling eight months) the writer acted as chief field geologist in the East Arm for Vestor Explorations Ltd. It is on this field experience, mostly centered upon the Simpson Islands area, that this study is based. Because detailed mapping completed in the Simpson Islands area provides a better understanding of certain processes that were of importance in the geologic history of much of the East Arm sub-province and owing to a lack of detailed geologic information concerning the western sector of the East Arm, the thesis area is not treated in isolation.

The uranium mineralization encountered within the thesis area is similar to mineralization in sandstones of the Sosan Group elsewhere in the East Arm, particularily near Snowdrift and Reliance (map 1). The Simpson Islands deposits are thus seen as representatives of one type of uranium deposit found more extensively distributed through the East Arm. In a more general sense the East Arm represents a uraniferous



Map1: Location map.

metallogenic province which encompases other types of uranium deposits.

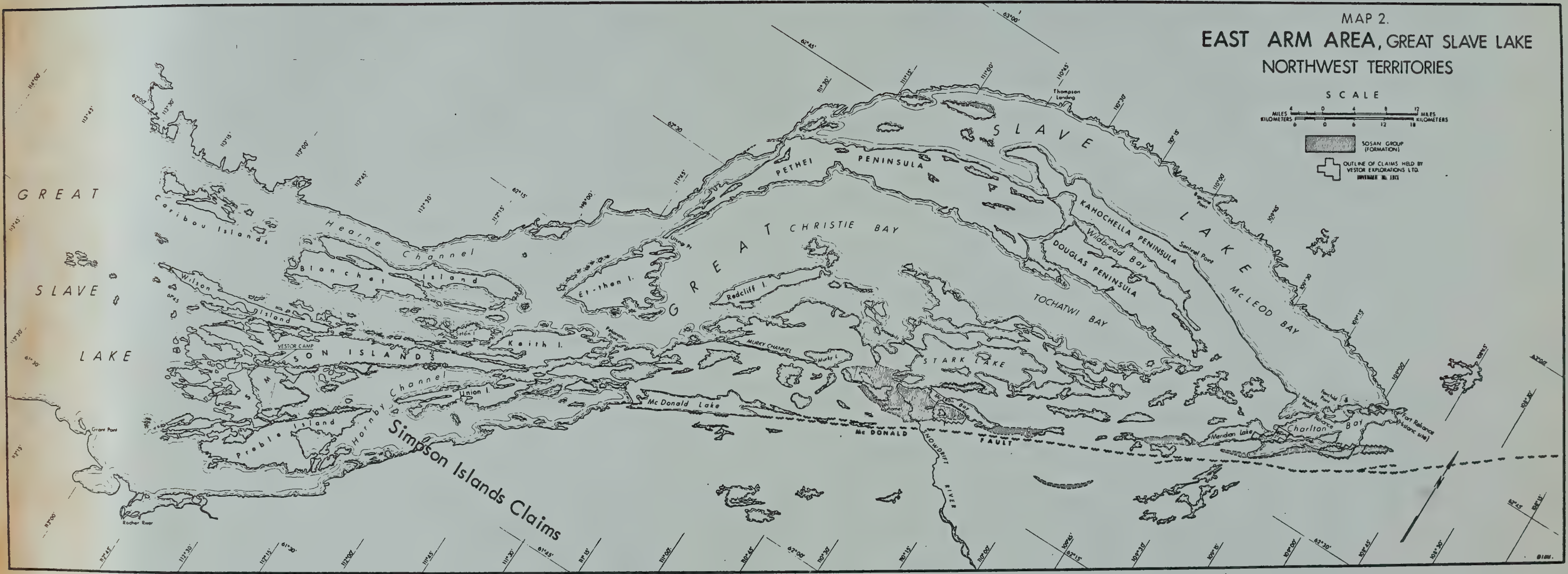
As a final consideration, some of the information derived from the thesis area (e.g. geochronology and sedimentation) bears upon general problems of other Aphebian sedimentary basins within the Northwest Canadian Shield.

Location of Thesis Area

The Simpson Islands Area, with which this study primarily deals, is located in the western portion of the East Arm of Great Slave Lake and is approximately centered on latitude 61° 45'N, longitude 112° 30'W. Map 1 shows the location of the area with respect the existing surface transportation facilities between Edmonton, Alberta and Yellowknife, N.W.T. Great Slave Lake provides an inexpensive transportation medium while charter air services are available in Yellowknife, Hay River and Fort Smith.

Map 2, East Arm area, shows the location of the Simpson Islands claims with respect to the East Arm of Great Slave Lake and other claims held in 1972 by Vestor Explorations Ltd. which covered favorable uranium prospecting areas and known occurrences within the Sosan Group of sediments. All major outcrops of Sosan Group rocks are also shown on map 2.

Map 6, major faults in the Simpson Islands area, shows the planimetry and existing geographic names in the vicinity of the thesis area. Map 7, summary geology, places geographic names assigned for the purpose of this study as well as locating the two base lines used for detailed mapping control.



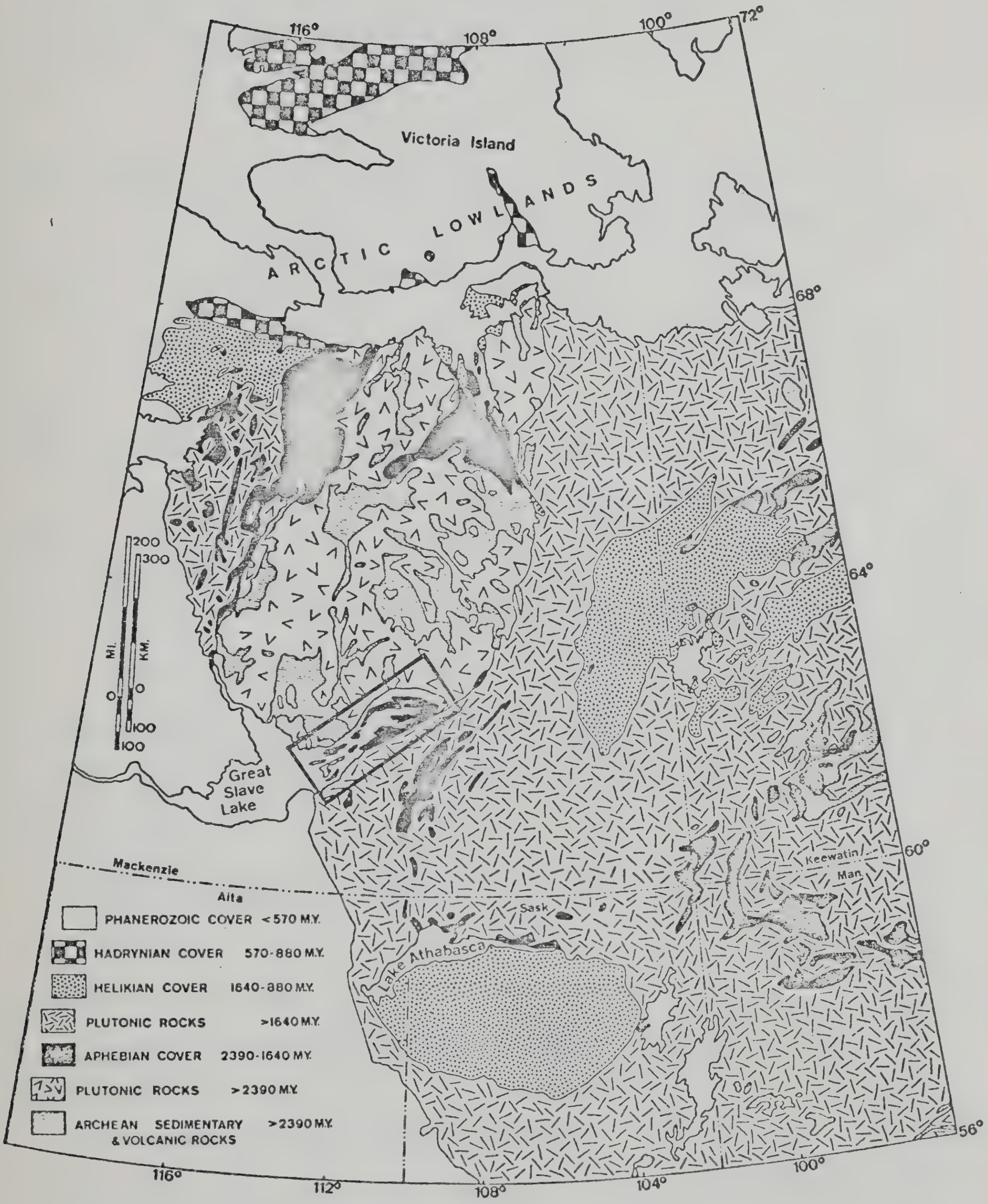
MAP 2.

EAST ARM AREA, GREAT SLAVE LAKE
NORTHWEST TERRITORIES

Physiography and Surficial Geology

The topography of the East Arm as a whole contrasts with the surrounding areas of the Canadian Shield. The East Arm is an erosional basin developed in heterogeneous rocks and is characterized by widely varying topography, commonly with local relief of several hundred feet and cliffs or steep slopes. Ridges elongate in a northeast-southwest direction, parallel to the structural grain, are prominent. The surrounding granitic upland of the Canadian Shield presents a rather monotonous plateau on which low rounded hills rarely exceed 100 ft. Within the Simpson Islands area, the topography is somewhat more subdued than most of the East Arm, but local relief still reaches 400 ft. and numerous fault line scarps are present, the highest of which rises 350 ft. above lake level. Relief within the area underlain by the Hornby Channel Formation is generally very low (less than 100 ft.) except where cut by major faults. The granitic basement rocks rise with the highest relief above the less resistant sediments and the larger areas of granitic rocks exposed on Simpson Islands simulate the surrounding granitic shield terrane in appearance.

About half the thesis area is covered with Pleistocene and Recent deposits with outcrop comprising about 80 to 100% of ridges (along faults) and lakeshore areas. The cover is predominantly sandy till and muskeg which in most instances likely developed on till. Drainage is disrupted and runoff is limited to the early spring due to a dry climate. Small areas of Pleistocene beach shingle are abundant and were seen as high as 200 ft. above present lake level. The only extensive areas of stratified sand were seen east and south of Paddlefish Lake and are thought to be post-glacial beach sands as they lie well below the level of the upper


116°
108°
100°
72°
Victoria Island
ARCTIC LOWLANDS
68°
64°
60°
56°
200
300
MI.
KM.
0
0
100
100
Great Slave Lake
Mackenzie
Alta
Keewatin
Man.
Sask
Lake Athabasca
PHANEROZOIC COVER <570 M.Y.
HADRYNIAN COVER 570-880 M.Y.
HELIKIAN COVER 1640-880 M.Y.
PLUTONIC ROCKS >1640 M.Y.
APHEBIAN COVER 2390-1640 M.Y.
PLUTONIC ROCKS >2390 M.Y.
ARCHEAN SEDIMENTARY & VOLCANIC ROCKS >2390 M.Y.
116°
112°
108°
104°
100°

Map 3: Regional geologic setting of the East Arm Fold Belt (enclosed in rectangle).
After Hoffman (1969).

beach shingle. Roche moutonnée topography is prevalent and, together with glacial striae, indicates the Pleistocene ice movement was towards the southwest, down the axis of the East Arm.

Previous Work

The regional geology of the western part of the East Arm is only very generally understood and the only mapping that covered most of the area was that of Stockwell (1936) which was carried out from 1929 to 1931 with a few modifications dealing with a small portion of the area by Reinhardt in 1969, and 1972. The geology of the Simpson Islands area as mapped by Stockwell is presented in map 4. The stratigraphic nomenclature is basically that of Stockwell (op. cit) as revised and amplified by Hoffman (1968b). No maps have yet been published which incorporate Hoffman's revised nomenclature. The stratigraphic work of Hoffman (1968, 1969, 1970, 1973) and Hoffman et al. (1970) has contributed greatly to the understanding of the geologic development of the East Arm as a whole and the tectonic environment during deposition of the Great Slave Supergroup and Et-then Group sediments.

Contributions primarily concerned with the geology of the East Arm are listed below:

1) Bell (1902): Reconnaissance regional geology.

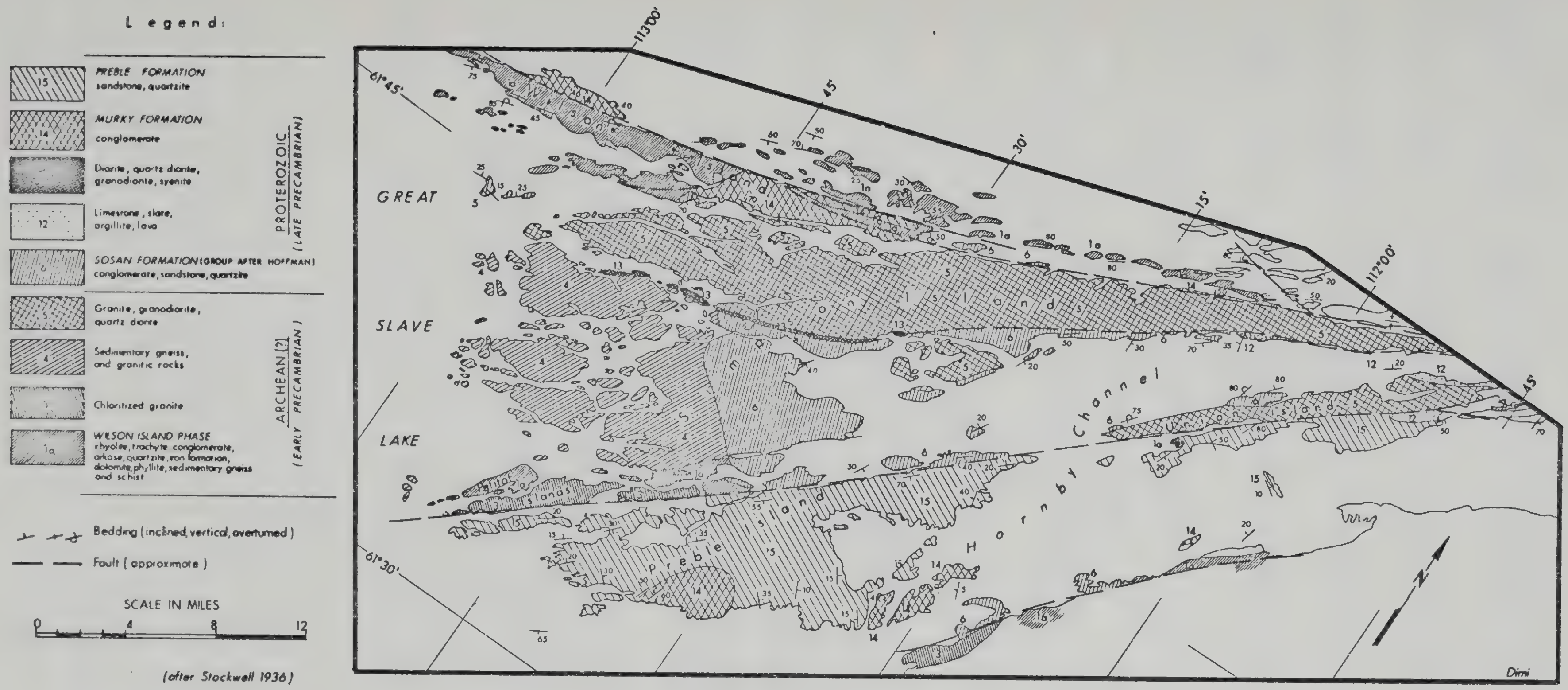
2) Rutherford (1929): Description of stomatolitic dolomites in the East Arm.

3) Lausen (1929): First attempt at systematic stratigraphy.

4) Stockwell (1933): First systematic report of the geology of the East Arm.

5) Stockwell (1936): First geological map of the East Arm (G.S.C. maps 377A and 378A; 1 inch to 4 miles).

6) Brown (1950a): Placed Stockwell's geologic mapping of the west half of the East Arm on an adequate topographic base.


Legend:
15 PREBLE FORMATION sandstone, quartzite
14 MURKY FORMATION conglomerate
Diorite, quartz diorite, granodiorite, syenite
12 Limestone, slate, argillite, lava
6 SOSAN FORMATION (GROUP AFTER HOFFMAN) conglomerate, sandstone, quartzite
PROTEROZOIC (LATE PRECAMBRIAN)
5 Granite, granodiorite, quartz diorite
4 Sedimentary gneiss, and granitic rocks
3 Chloritized granite
1a WILSON ISLAND PHASE rhyolite, trachyte conglomerate, arkose, quartzite, iron formation, dolomite, phyllite, sedimentary gneiss and schist
ARCHEAN (?) (EARLY PRECAMBRIAN)
Bedding (inclined, vertical, overturned)
Fault (approximate)
SCALE IN MILES
0
4
8
12
(after Stockwell 1936)
113°00'
45
30'
15'
112°00'
45'
61°45'
61°30'
GREAT
SLAVE
LAKE
Wilson Island
Simpson Islands
Hornby Channel
Preble Island
N
Dimi

Sketch Map Of The Geology Of The Simpson Islands, N. W. T.

Map 4

7) Brown (1950b): Modified Stockwell's geology of the Fort Reliance area.

8) Brown (1950c): Modified Stockwell's geology of the Christie Bay area.

9) Wright (1951): Further modified the geology of the Christie Bay map area.

10) Wright (1952): Further modified the geology of the Reliance map area.

11) Barnes (1951): Mapped Snowdrift area at 1 inch to the mile.

12) Barnes (1952): Mapped McLean Bay area at 1 inch to the mile.

13) Stockwell _et al_. (1968): Compiled final maps of the Christie Bay and Fort Reliance areas at 1 inch to 4 miles.

14) Hoffman (1968): Detailed stratigraphic analysis and reclassification of the Great Slave Supergroup.

15) Hoffman (1969): Sedimentological analysis and paleogeographic reconstruction of the Great Slave Supergroup and Et-then Group.

16) Reinhardt (1969b): Map modifications and general structure in the Wilson Island - Petitot Islands area at 1 inch to 4 miles.

17) Hoffman _et al_. (1970): Made stratigraphic and paleogeographic correlations among the Great Slave Supergroup/Et-then Group and other areas of Proterozoic sediments around the Slave Province.

18) Reinhardt (1972): General description of exotic breccia occurrences in the area of Simpson Islands and Wilson Island.

19) Hoffman (1973): Synthesis of the early Proterozoic stratigraphic and tectonitic evolution of the East Arm area and the western margin of the Slave craton.

20) Morton (1974): Reported on sandstone type uranium deposits in the East Arm.

Geological Setting

The East Arm of Great Slave Lake is underlain by a Hudsonian fold belt developed in Aphebian sedimentary and volcanic rocks which were deposited on Archean igneous and metamorphic basement. The relationship of the East Arm fold belt to the northwestern Canadian Shield is shown in map 3. This fold belt is classified as a sub-province of the Churchill struc-

tural province by virtue of the predominantly Aphebian rocks outcropping in the East Arm (Stockwell, 1964). The basement rocks are, however, definitely Archean and outcrop in several areas, especially in the western end of the East Arm. Although the regional folding of the East Arm involved the Proterozoic sediments the basement was not involved to any appreciable extent. Several K/Ar age determinations on the crystalline basement rocks have produced ages ranging from 2370 m.y. to 2575 m.y. (G.S.C. isotopic ages 60-51, 60-50, 61-69, 61-76, 61-77, 63-81, and Burwash and Baadsgaard, 1962). Locally some updating of K/Ar ages may have occurred in cataclastically deformed basement rocks along major faults (Reinhardt, 1969a). In view of the Archean age of the crystalline basement rocks, one might more aptly consider the boundary between the Slave and Churchill structural provinces in the East Arm as the unconformity between the Archean basement rocks and the Proterozoic cover rocks. The Proterozoic sediments of the East Arm are developed on, and marginal to, the Slave craton.

The East Arm itself is a structural depression in which Proterozoic sediments accumulated and survived. On a regional scale, the Proterozoic sediments dip homoclinally south, away from the Slave nucleus, in the north, but are complicated by folding and extensive faulting in the south side of the East Arm. The folds and major faults trend about N60 E, parallel to the East Arm trough and large vertical, as well as transcurrent movements on the southern bounding fault system, the McDonald fault system, have down-dropped and thus preserved the Proterozoic sediments of the East Arm. This structural trough is gently upturned at both ends.

Four major episodes of early Proterozoic sedimentation separated by unconformities have been recognized in the East Arm as shown in table 1.

Stratigraphic Unit	Thickness	Age
Et-then Group	13,000 ft. plus	Latest Aphebian or Paleohelikian
Great Slave Supergroup	26,000 ft. plus	Aphebian
Union Island Group	3,000 ft. plus	Lower Aphebian
Wilson Island Group	15,000 ft. plus	Lower Aphebian
Granitic and High Grade Metamorphic Complex		Archean

Table 1: Major Stratigraphic units separated by unconformities in the East Arm. Data from Stockwell (1933), Reinhardt (1969b) and Hoffman (1968, 1969, 1970).

Table 2 presents brief lithologic descriptions of all formations while figure 1 presents a diagrammatic stratigraphic cross-section of all groups except the Wilson Island Group which was recently reclassified from Archean (Stockwell, 1933) to Aphebian (Reinhardt, 1969b). The unconformities separating each of the four major episodes of sedimentation represent fundamental changes in the environment of sedimentation as well as significant erosional intervals. The Wilson Island Group is the only sedimentary unit which shows evidence of extensive regional metamorphism and accordingly is much more highly deformed than later sediments. There may have been another period of moderate deformation after deposition of the Union Island Group as is evidenced by its more pervasive and closer style of folding compared to the overlying lower formations of the Great Slave Supergroup. This difference in style of deformation may, however, be due to contrasting competency resulting from lithologic dissimilarity. The Wilson Island Group has no known analog elsewhere around the Slave craton. Little can be inferred about its geologic history, except that it represents a long period of Lower Aphebian sedimentation and volcanism which

TABLE OF FORMATIONS

EON	ERA	SUPER-GROUP	GROUP	FORMATION	LITHOLOGY
PROTEROZOIC	PALEO-HELIKIAN	1295 m.y. Mackenzie Swarm			Diabase, northwest trending dykes
		Intrusive contact			
	APHEBIAN or PALEOHELIKIAN				Diabase, sills and shallow dipping dykes
		Intrusive contact			
			Et-then Group	Preble Formation 10,000 +	Sandstone, buff to red, feldspathic, weakly indurated, crossbedded; minor conglomerate, shale
				Murky Formation 0 – 3,000	Conglomerate, buff to red, very thick bedded, weakly indurated; minor lithic sandstone lenses, shale, mudcracks, caliche horizons
	Unconformity				
	APHEBIAN	1845 m.y.			Quartz-diorite, laccoliths and minor dykes (may be older than the upper Stark Formation)
		Intrusive contact			
		GREAT SLAVE SUPERGROUP	Christie Bay Group	Pearson Formation 550 +	Basalt, columnar; minor argillite, argillite-pebble conglomerate
				Portage Inlet Formation 705	Shale, red to brown, mudcracked, halite and gypsum casts; minor thin beds of siltstone and sandstone
				Tochatwi Formation 1,870 – 2,600	Sandstone, red to buff, fine-grained, lithic and feldspathic, crossbedded, ripple-marked, mudcracked; minor conglomerate and shale
				Stark Formation 2,000 ?	Mudstone, red, brecciated, hematitic, halite casts; beds of interlaminated dolomite and limestone, stromatolitic, ripple-marked, crossbedded, convolute bedded; extensive non-tectonic breccias
			Disconformity ?		
			Pethei Group	Hearne Formation 0 – 300	Limestone, grey to white, thick bedded, medium- to coarse-grained, crystalline, massive to mottled; minor stromatolitic limestone and dolomite
				Wildbread Formation 0 – 600 ?	Limestone, grey to white, thin- to medium-bedded oolitic, stromatolitic, laminated, mottled, or crystalline; minor dolomite, stromatolitic; some sections extensively dolomitized
				Pekanatui Point Formation 0 – 340	Limestone, white, very thin bedded aphanitic; very thinly interbedded limestone and argillite; argillite with limestone nodules; interbedded greywacke and argillite; nodular argillaceous dolomite and limestone; limestone 'debris flow' breccia beds; some sections extensively dolomitized
				Blanchet Formation 0 – 995	Greywacke, dark red-brown to dark green, thin-bedded, graded bedding, interbedded argillite and interlaminated argillite and limestone; argillite with limestone nodules
				McLean Formation 0 – 395	Argillite, red-brown, very thin bedded, calcareous, interbedded limestone or limestone nodules; some sections extensively dolomitized
				Utsingi Formation 0 – 900	Limestone, grey, medium- to thick-bedded, medium-grained, crystalline, mottled to laminated; minor stromatolitic limestone
				Taltheilei Formation 0 – 390	Dolomite, brown, medium- to thin-bedded fine-grained, crystalline, stromatolitic, laminated, or massive; stromatolitic limestone with dolomite laminations; calcite cemented dolarenite, dolorudite
				Douglas Peninsula Formation 55 – 110	Marlstone, red-brown, laminated, gypsum casts; argillite, hematitic, limestone and jasper nodules

TABLE OF FORMATIONS (cont'd.)

EON	ERA	SUPER-GROUP	GROUP	FORMATION	LITHOLOGY
PROTEROZOIC	APHEBIAN	GREAT SLAVE SUPERGROUP	Kahochella Group	Charlton Bay Formation 30 – 500	Argillite, dark green, calcareous concretions; minor graded siltstone beds, bentonite beds
				McLeod Bay Formation 450 – 1,050	Shale, red, calcareous concretions, intraformational concretion conglomerate; minor dark green argillite
				Gibralter Formation 600 – 3,450	Shale, red; minor oolitic hematite, intraformational conglomerate, stromatolites, marlstone beds, gypsum casts
				Seton Formation 0 – 4,300	Andesite, massive, columnar, or brecciated; basic ash-fall tuff, agglomerate; reworked basic lithic and vitric tuff, volcanic conglomerate; minor columnar rhyolite flows; minor sandstone, hematitic siltstone, oolitic hematite, gypsum casts
			Sosan Group	Akaitcho River Formation 0 – 1,000	Siltstone, red, micaceous, massive to ripple-marked, mudcracked, thin-bedded; white, crossbedded, glauconitic sandstone with Scolithus-like tubes; red, micaceous shale; minor oolitic hematite, conglomerate
				Kluziai Formation 1,450	Sandstone, pink, medium-grained, crossbedded, shale-pebble conglomerate, heavy mineral bands
				Unconformity ?	
				Duhamel Formation 0 – 915	Dolomite, stromatolitic, oolitic, intraformational conglomerate, chert nodules; crossbedded calcarenite and orthoquartzite; ripple-marked, mudcracked siltstone
				Hornby Channel Formation 0 – 5,000 +	Sandstone coarse-grained, grey, crossbedded, feldspathic; minor conglomerate, stromatolitic dolomite, siltstone
		Unconformity ?			
			Union Island Group	unnamed	Dolomite, brown, massive, quartz veins
				unnamed	Volcanic rocks, basic, pillowed or brecciated flows; minor slate
				unnamed	Slate, grey; minor greywacke
				unnamed	Slate, black, carbonaceous; dark grey dolomite
				unnamed	Dolomite, massive to laminated; minor red argillite, arkose and conglomerate at base
Unconformity					
ARCHEAN	2460 m.y.				Granodiorite; migmatite; granite pegmatite
	Intrusive contact				
			Wilson Island Group	unnamed	Slate, dark grey; minor siltstone
				unnamed	Siltstone, light grey, thin-bedded, interbedded with dark grey argillite
				unnamed	Quartzite, grey to red to white, crossbedded; minor hematitic quartzite, argillite
				unnamed	Dolomite, grey to brown, massive to laminated; minor argillite, micaceous dolomite
				unnamed	Quartzite, grey to white, crossbedded; minor conglomerate, feldspathic quartzite
				unnamed	Volcanic rocks, dark grey to dark brown, porphyritic, sheared, ignimbritic?

Table 2: Table of formations. From Hoffman (1968).

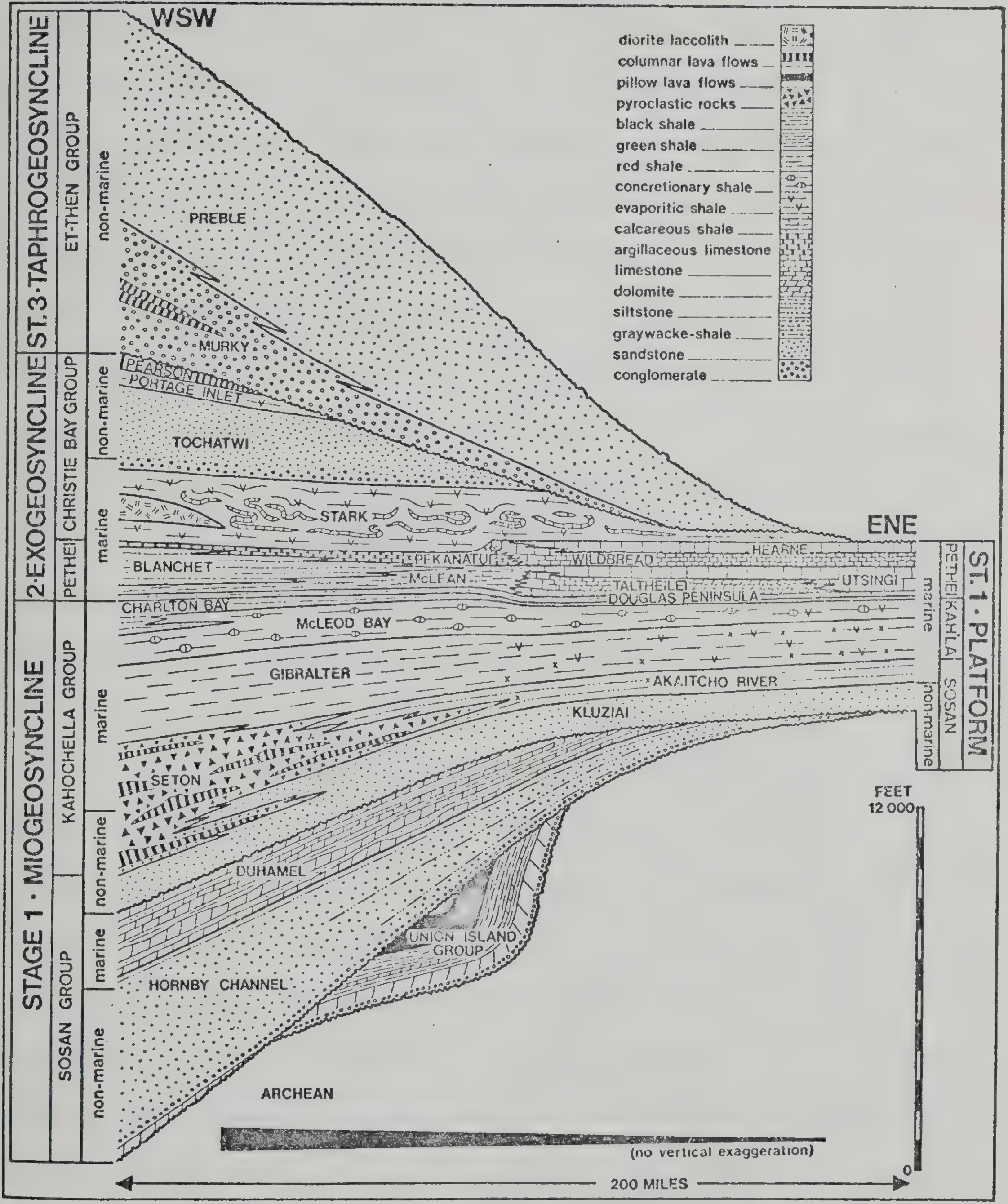


FIG. 1: Stratigraphic cross-section of Proterozoic formations from the northeast to the southwest end of the East Arm Fold Belt. From Hoffman (1969).

pre-dated deposition of the Union Island Group and Great Slave Supergroup.

Hoffman (1968, 1969, 1970, 1973) and Hoffman, Fraser and McGlynn (1970) have commented extensively upon the sedimentological and paleogeographic development of the Great Slave Supergroup and Et-then Group. The prevailing theory, as principally formulated by Hoffman, portrays the Union Island Group and the Great Slave Supergroup as an integral part of a classic orthogeosynclinal sequence which was deposited from about 2000 to 1750 m.y. ago and which includes the Aphebian strata of the Epworth, Goulburn and Snare Groups which also lie on and marginal to the Slave craton. Individual stratigraphic units within all these groups of sediments have been correlated on the basis of lithostratigraphic similarity. This geosyncline which has been termed the Coronation geosyncline, extended across the present western margin of the Slave province in an arcuate northerly trend which was convex to the west. The orogenic belt of the geosyncline is presently represented in the Bear province while farther south it is thought to lie just west of the East Arm. The Union Island Group, Great Slave Supergroup and Et-then Group were deposited in the actively subsiding East Arm structural trough which Hoffman (1973) has termed the Athapuscow aulacogen. This sedimentary trough, controlled by the east northeast striking McDonald fault system, opened at its west end into the Coronation geosyncline and was oriented normal to the geosynclinal axis (figure 2).

Deposition of the unusually thick trough filling began with the pre-quartzite phase Union Island Group composed of non-stromatolitic dolomite, mudstone, siltstone and submarine basalts. The succeeding Great Slave Supergroup is predominantly miogeosynclinal in character.

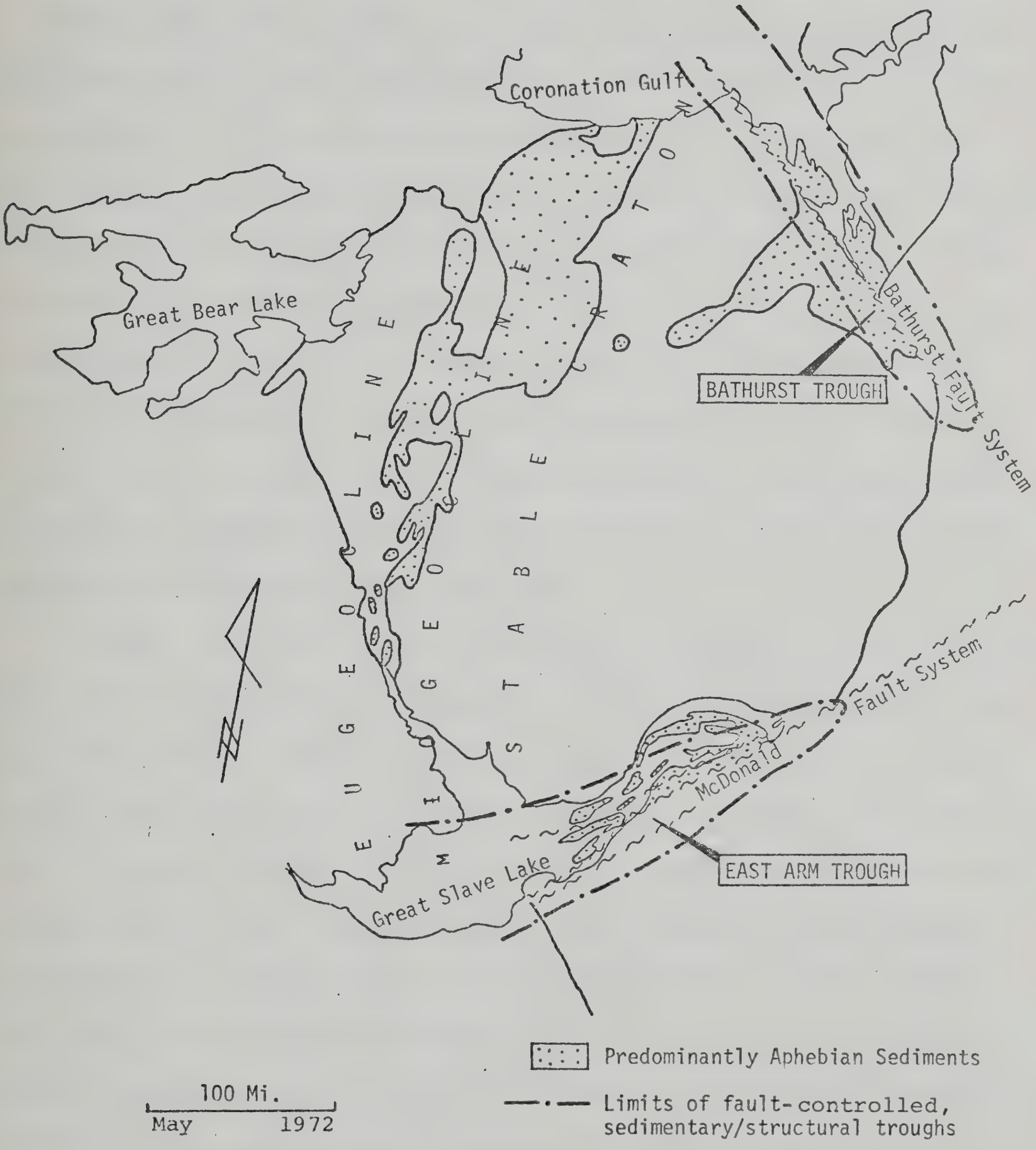


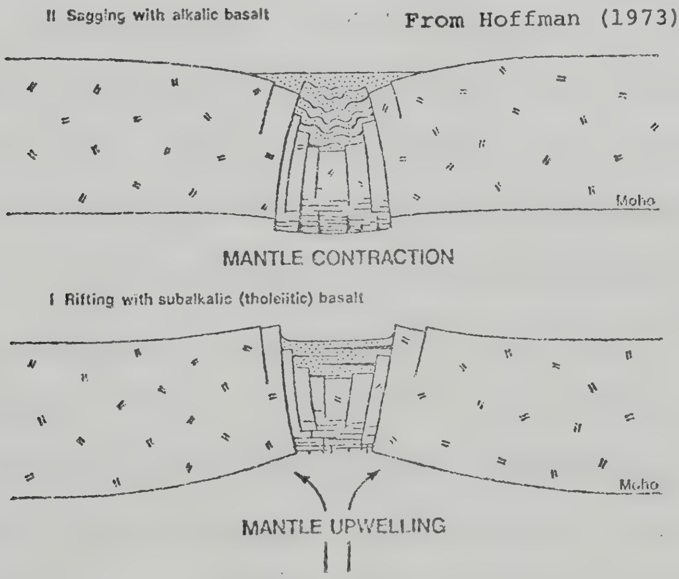
Figure 2: Tectonic elements of the Slave Area during development of the Coronation Geosyncline (2200-1750 million years ago)

Its deposition began with a quartzite phase, the Hornby Channel Formation, comprising fluvial, conglomeratic subarkose shed from the stable platform and transported down the axis of the East Arm trough towards the southwest. The thesis area is principally underlain by this formation. As described by Hoffman (1973) the quartzite phase was followed by successive deposition of a dolomite phase, pre-flysch phase, flysch phase, calc-flysch phase and molasse phase. The Great Slave Supergroup was then intruded by an extensive belt of tonalite and granodiorite laccoliths and stocks and folded approximately 1800 m.y. ago by compression normal to the East Arm axis. Erosion and deposition of a fanglomerate phase shed from active McDonald system faults concluded sedimentation in the East Arm. Helikian diabase dykes of the MacKenzie swarm and earlier extensive diabase sills cut all sediments and structures in the East Arm.

Hoffman (1973) has developed a model of the tectonic evolution of the East Arm structural trough, referred to as the Athapuscow aulacogen, which traces its history through three major stages. He envisions an initial rifting stage which involved crustal doming and development of a graben due to crustal extension. The pre-quartzite phase Union Island Group and quartzite phase Hornby Channel Formation were deposited in this graben. The subarkosic, conglomeratic sandstones of the Hornby Channel Formation were shed into this graben from the adjacent uplifted Archean basement. Crustal thinning occurred beneath the developing rift but the process was aborted before actual crustal separation. The second stage of the evolution of the aulacogen involved crustal sagging and foundering of the graben due to a shift from mantle upwelling to mantle contraction (figure 3). During this stage the subsiding trough was filled with sediments and volcanics from the pre-flysch phase through the molasse phase. Flysch and

molasse sediments were shed into the aulacogen from the rising orogenic belt of the Coronation geosyncline west of the East Arm. Evolution of the aulacogen concluded with a transcurrent stage during which fanglomerate phase sediments were deposited along the braided network of faults comprising the McDonald fault system. Hoffman (1973) concluded that transcurrent movements on the fault system produced "a complex pattern of uplifted and downdropped blocks" which provided the relief necessary for derivation of the fanglomerates.

Hoffman's stratigraphic analysis and Coronation geosyncline model, so painstakingly documented and elegantly proposed, seems beyond serious challenge at this time. His model for the tectonic evolution of the Athapuscow aulacogen, however, does seem somewhat more tenuous. Evidence will be discussed later to support a 2200 m.y. age for the beginning of the quartzite phase (Hornby Channel Formation) rather than the 2000 m.y. age suggested by Hoffman (1973). Apart from this detail alternatives to the Athapuscow aulacogen model are discussed in chapter II.


II Sagging with alkalic basalt
Moho
MANTLE CONTRACTION
I Rifting with subalkalic (tholeiitic) basalt
Moho
MANTLE UPWELLING

From Hoffman (1973).

FIGURE 3. Model for the transition from incipient rifting to crustal sagging in aulacogens in response to abandonment of a zone of mantle upwelling.

Mapping Techniques

Field mapping was done on a variety of scales due to variable geologic complexity and economic potential.

Geologic Mapping: The entire thesis area was mapped on a scale of one inch to 1000 feet based on an uncontrolled air photo mosaic enlargement. Some of the data presented on geologic maps constructed on this scale was derived from the work of senior field assistants. Mapping done on a scale of one inch to 200 feet utilized cut base and picket lines for control. The picket line spacing varied from 100 to 400 feet as shown on the maps. The two base lines were alidade surveyed, as were selected picket lines. All picket line spacings were chained at the distal ends of the picket lines. Detailed mapping done at one inch to 40 feet was based on alidade survey control as shown on the maps.

Radiometric Mapping: Data was recorded during radiometric mapping from a single, SRAT-SPP2-NF total count scintillometer (utilizing a 1x1.5 inch thallium doped sodium iodide scintillator) held at waist level above the outcrop surface. Radiometric contour maps of the areas covered by both base lines were constructed on a scale of one inch to 200 feet by plotting representative radiation levels as closely as was necessary to adequately define the local variations. Isorads around anomalies were traced and plotted directly in the field. Although this method is somewhat subjective, it was found that the results adequately defined the variations in radiation on the scale used. The detailed radiometric map of Zone 5 (1 inch = 40 feet) was constructed from data taken on a rigid square grid pattern with measurements every 10 feet where radiation was within the normal background range. Where radiation levels exceeded background (100 cps), measurements were based on a 5-foot square grid. This

method produced a highly reliable and objective, detailed map. The radiometric detail obtained on Zone 5 provided information that could be applied to other radiometrically anomalous zones and the other zones were not surveyed in such detail. Radiometric contour maps of the other anomalous zones were constructed by close-spaced traverses utilizing alidade control with measurements taken every five to ten feet along the intersecting traverse lines. All contouring was done by hand.

CHAPTER II

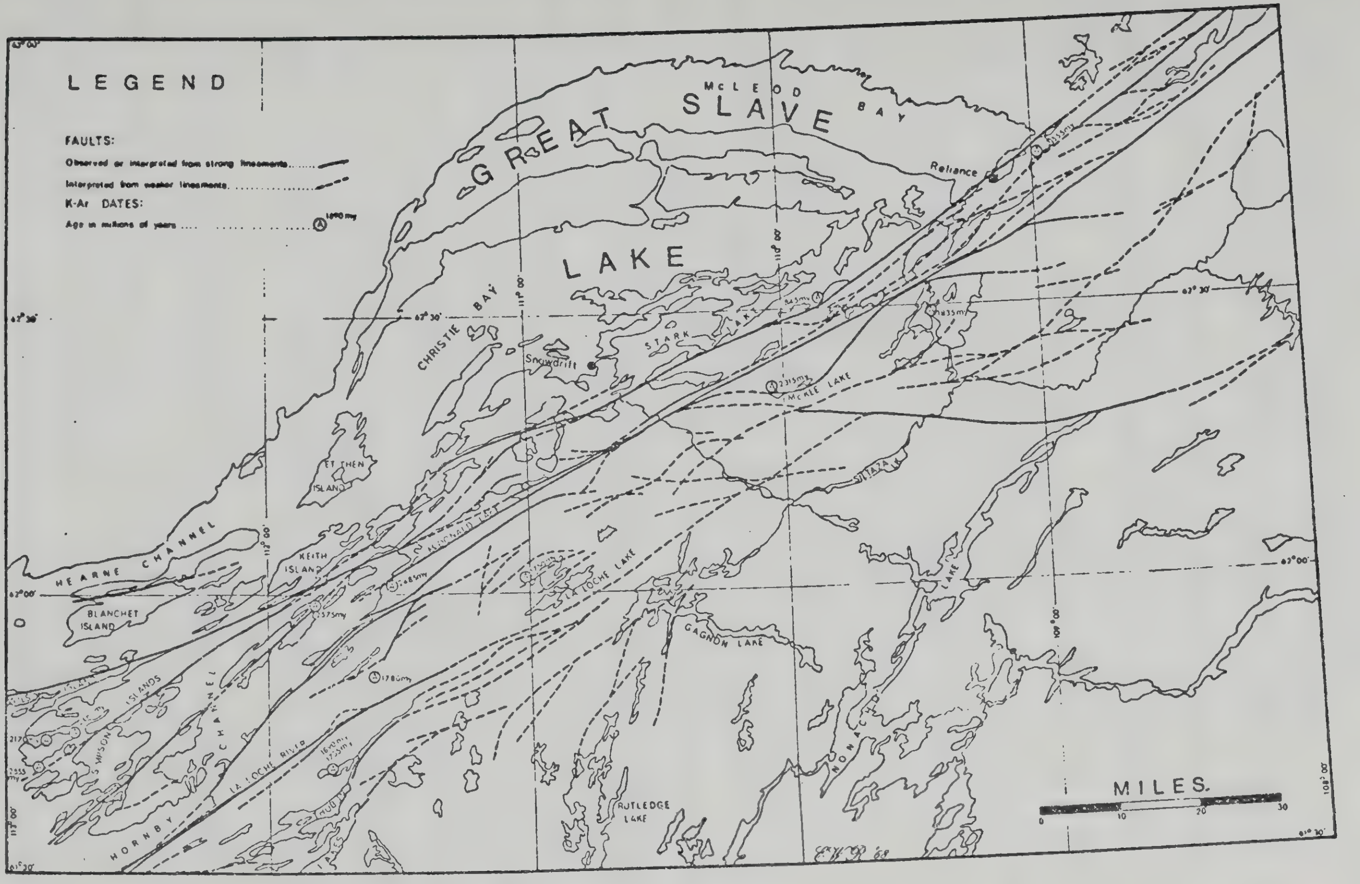
STRUCTURAL GEOLOGY

Introduction

The geological development of the East Arm sub-province was dominated by the evolution of the long-lived McDonald fault system. It is for this reason that a general overview of this major crustal structure is essential to the understanding of many features within the thesis area. In addition, information derived from study of the thesis area adds to the understanding of the evolution of the McDonald fault system and its influence upon Aphebian sedimentation. Reinhardt (1969a, 1969b) was the only author who dealt systematically with the McDonald fault system and map 5 presents his interpretation of the fault pattern existent in the East Arm. The McDonald fault system has been traced magnetically under the Paleozoic cover rocks southwest of the East Arm to the Rocky Mountain foothills (Haines _et al._, 1971) while geological mapping has traced its northeast extension as far as the Dubawnt Group (Donaldson, 1967); a total distance of about 800 miles.

Morphology of the McDonald Fault System in the East Arm

The observed fault pattern is one typical of many transcurrent systems. It is composed of parallel and sub-parallel master faults with numerous arcuate splays which commonly recurve back towards the major faults as well as sigmoidal faults which connect parallel master faults and which likely served to transfer transcurrent movement from one main fault to the next. Northeast of McDonald Lake the system is characterized by two parallel master faults (the southeast one being the McDonald fault proper) spaced about four to six miles apart, accompanied by the



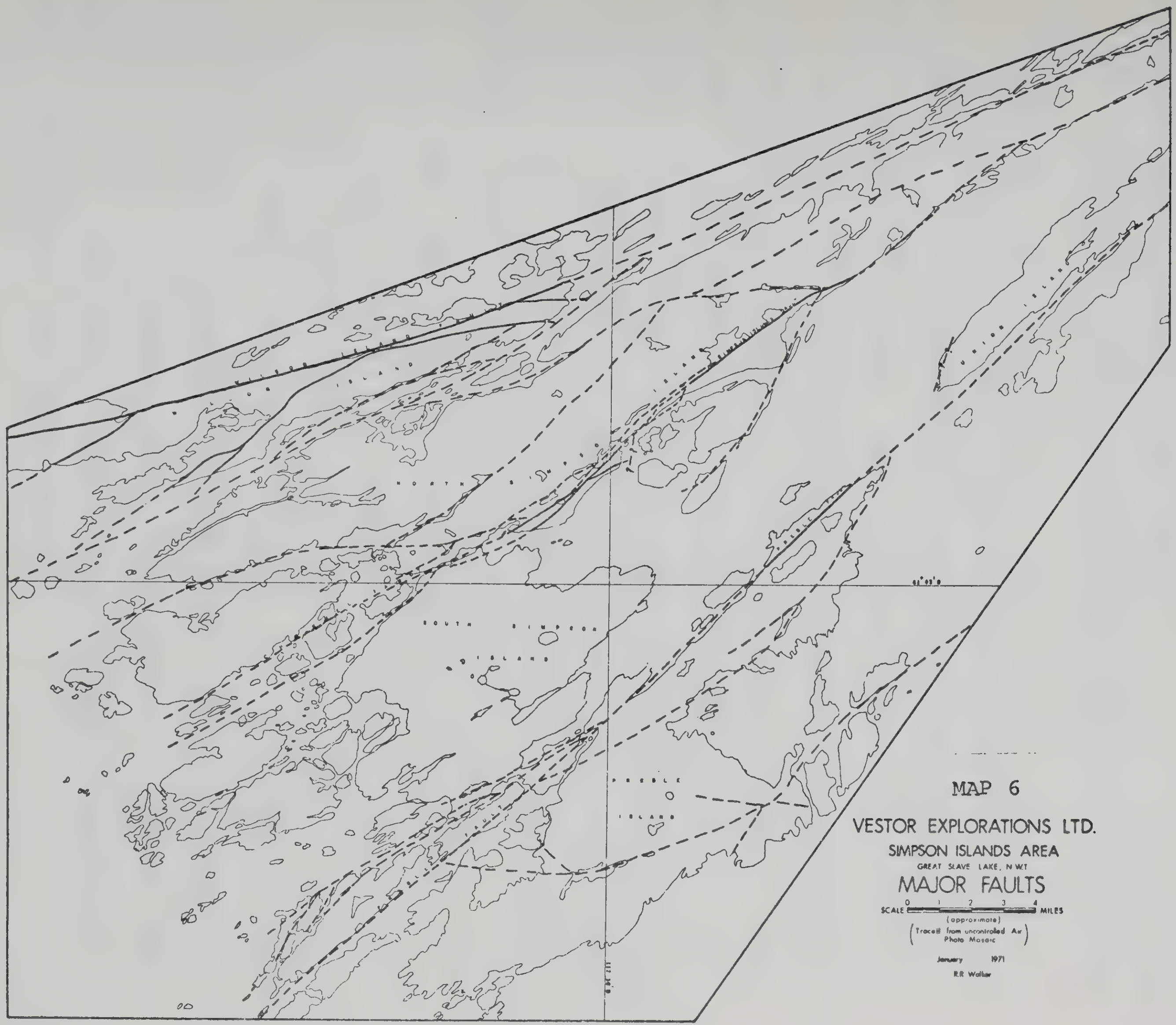
Map 5: The McDonald fault system. From Reinhardt (1969).

usual splays and interconnecting faults. This basic morphology is commonly observed along transcurrent faults of widely differing scale and is a typical pattern produced microscopically and mesoscopically in Riedel shear experiments conducted in the laboratory.

The area immediately southwest of McDonald Lake appears to be a focal point where the McDonald fault proper gives way to four major splays that diverge in a southwesterly direction. About six miles north of McDonald Lake the northwesterly of the two master faults described above also begins to diverge, as the Murky fault, to a more westerly strike than the McDonald fault, and is probably continuous with the fault transecting Blanchet Island or underlying Hearne Channel. Such splaying is common at the ends of major transcurrent faults; however, it is known that the McDonald system does not terminate in this region but extends well to the southwest under Paleozoic cover. It is significant that the McDonald fault proper does terminate in the McDonald Lake region and it appears that the southwest extension of the system is in fact an extension of the La Loche River fault. The most southerly of the four splays southwest of the McDonald fault (between McDonald Lake and the mouth of the La Loche River)provides a link between the McDonald and La Loche River faults along which major movement was likely transferred.

McDonald Fault System in the Simpson Islands Area

The pattern of major faults in the Simpson Islands area is presented in map 6. The area is transected by three of the major fault splays which diverge southwest from the McDonald fault. These major splays are themselves systems of related faults which have been named for the purpose of this report as follows:



MAP 6

VESTOR EXPLORATIONS LTD.
SIMPSON ISLANDS AREA
GREAT SLAVE LAKE, N.W.T.
MAJOR FAULTS
SCALE 0 1 2 3 4 MILES
(approximate)
(Tracell from uncontrolled Air Photo Mosaic)
January 1971
R.R. Walker

i) Wilson Island fault system - composed of the Wilson Island fault and related faults.

ii) Simpson Islands fault system - composed of the Simpson Islands fault, the Channel fault and related splays.

iii) Preble fault system - composed of the Preble fault and related splays.

The fault patterns of these three equally spaced subsystems of the McDonald fault system are analogous to the pattern characteristic of the McDonald system on a regional scale. One notable feature is the tendency for splays, sometimes symmetrical, to curve away from a linear master fault where the latter undergoes a slight inflection. Reinhardt (1969a) has suggested the possibility that considerable dextral shear, in the order of 40 miles, may have been accommodated by the Wilson Island fault; however, I can see no reliable evidence to indicate the scale of transcurrent movement on any of the three major splays. Apparent normal displacements on the three subsystems are as follows:

i) Wilson Island system - northwest side down

ii) Simpson Islands system - northwest side up

iii) Preble system - northwest side up

The major faults in the Simpsons Islands area are vertical to very steeply dipping and are marked by prominent fault line scarps and juxtaposed contrasting lithologies. Broad ridges transected by narrow axial depressions are common where normally recessive sediments (e.g. Hornby Channel Formation) are cut by major faults.

History of Faulting

The characteristic braided fault pattern and regional extensiveness of the McDonald fault system suggests that this system was initiated as

a fundamental transcurrent fault zone which penetrated the crust. Regionally extensive, penetrative cataclasis along faults of the McDonald system in crystalline basement rocks of both the Slave and Churchill provinces (Reinhardt, 1969a, 1969b) is consistent with large-scale transcurrent movement. Mylonite belts up to 5 miles wide occur between the McDonald fault scarp and Nonacho Lake. Gently dipping mylonite lineations mapped in the La Loche River area (Reinhardt, 1969a) further confirm transcurrent movement. Offsets mapped in the same area indicate a dextral sense of shear.

Where McDonald system faults transect Union Island Group, Great Slave Supergroup and Et-then Group rocks the fault planes are generally characterized by narrow, linear, well-defined breaks usually marked by fault breccia, quartz or carbonate veins and very narrow mylonite seams. This style of deformation is in marked contrast to the penetrative cataclasis which affected crystalline basement rocks of the Slave and Churchill provinces. Reinhardt (1969b) noted that penetrative deformation also affected the Wilson Island Group but to a lesser degree than the crystalline basement. This contrast in style of deformation may be attributed to two causes. Firstly, the contrast may be due to extensive transcurrent movement having been largely antecedent to deposition of much of the Proterozoic sediments. Secondly, deformation along faults in the crystalline basement rocks likely occurred at greater depths of burial than deformation along faults in the Proterozoic sedimentary rocks. Evidence supporting this contention has been documented in the area south of the East Arm by Reinhardt (1969a) who wrote: "Where different depth levels have been brought into coincidence through vertical components of fault movements (south side up) the deeper level or south sides show the more intense

mylonitization. For instance, the fault that occurs a few miles south of McDonald Lake and strikes parallel to the McDonald fault separates virtually unsheared granite and low-grade schist from highly mylonitized migmatite, granitic rock and higher grade gneiss to the south. One tentative explanation for this is that the higher level expression of transcurrent shear was confined to definite fault planes spaced at regular intervals whereas at greater depth, movement was translated by a myriad of closely-spaced, sub-parallel planes of shear." Greater depths of shearing of the crystalline basement in the East Arm implies considerable erosion after transcurrent movement and before deposition of the Great Slave Supergroup. Less intense penetrative deformation of the Wilson Island Group implies less extensive transcurrent shearing and/or an intermediate depth of shearing consistent with its greenschist facies metamorphism.

Within the thesis area mylonites were mapped in Hornby Channel Formation rocks along the Preble fault on Ped Peninsula on the north side of Preble Island. Here a deformed belt several hundred feet wide is characterized by cataclasite lenses up to a few hundred feet by fifty feet and numerous mylonite bands up to several feet across. Quartz veins with associated mylonite occur in the Hornby Channel Formation in widths up to 100 feet along the Simpson Islands fault and Channel fault. These occurrences seem to confirm the existence of continued transcurrent shearing after the beginning of Great Slave Supergroup sedimentation. Within the Hornby Channel Formation, rapid lateral facies variations, lithologies atypical of the formation and soft sediment deformation features along the Channel, Simpson Islands and Preble faults indicate transcurrent movement locally affected sedimentation. These features will be discussed in chapter IV.

A major albite syenite dyke in the thesis area appears to have intruded faults of the Simpson Islands system. This indicates that fault movement began prior to approximately 2200 m.y. ago. Dextral offset of the dyke by one of its controlling faults indicates that transcurrent movement recurred after dyke emplacement. The age and structural relationships of this dyke are discussed in subsequent chapters.

In the La Loche River area, K-Ar dating of micas recrystallized in mylonites during the waning stages of shear indicate that mylonitization effectively ceased by 1735 m.y. ago (Reinhardt, 1969a). Thus it appears that the transcurrent McDonald fault system was active throughout most, and perhaps all, of Aphebian time.

The McDonald fault system lies on the boundary between the Slave and Churchill structural provinces. The Churchill province is composed mainly of Archean rocks updated by Hudsonian plutonism and cataclastic and retrogressive metamorphism. Immediately south of the East Arm the principal agency of updating has been cataclasis accompanied by retrogressive metamorphism along the McDonald fault system (Reinhardt, 1969a). Hoffman (1973) stated, "the granitic rocks south of the Great Slave basin ... are believed to have been intruded in the Archean".

It appears that the boundary between the two provinces is not clearly defined by a single fault of the McDonald system. Available K-Ar dates along the fault zone (map 4) combined with Reinhardt's (1969a) observation of deeper erosional levels on the south sides of major faults suggest that the boundary between the two provinces is a broad zone coincident with the McDonald fault system across which fault slices generally step up to deeper erosional levels from north to south. The updated Hudsonian ages of Churchill province rocks appear the have been brought to the present

erosional surface by major uplift of the Churchill Province relative to the Slave Province across the McDonald fault system. Thus the last stage in the evolution of the McDonald fault system involved major vertical displacements on the pre-existent transcurrent faults. It is not possible to evaluate whether transcurrent displacement continued during the uplift of the Churchill Province at the end of the Hudsonian orogeny but the evidence does seem inconsistent with Hoffman's (1973) conclusion that the last stage of movement on the McDonald fault system, during deposition of the Paleohelikian Et-then Group, was essentially transcurrent.

Barnes (1951) and Hoffman (1968, 1969) concluded that the East Arm had at one time developed as a graben along its entire length. More recently Hoffman (1973), in developing his model of the Athapuscow aulacogen, concluded that rifting and graben formation had been the initial stage in the development of the aulacogen. However, I find evidence of a significant graben lacking northeast of McDonald Lake. Instead it appears that movements on the two parallel master faults of the system in the area produced "stepping up" to the south with most of the vertical movement accommodated on the McDonald fault proper. The four mile spacing of the two major faults is inconsistent with a graben, while no evidence of a third major fault to the northwest is known. Figure 4 presents the proposed crustal structure across the East Arm northeast of McDonald Lake.

A graben does appear to be superimposed on the major splays of the McDonald system southwest of McDonald Lake. This graben appears to exist between a fault underlying Hearne Channel and the major splay connecting the La Loche River and McDonald faults. The two fault blocks between the Wilson Island and Preble faults represent a central horsted block relative to the enclosing graben. The exposed graben is wedge-shaped and about 30

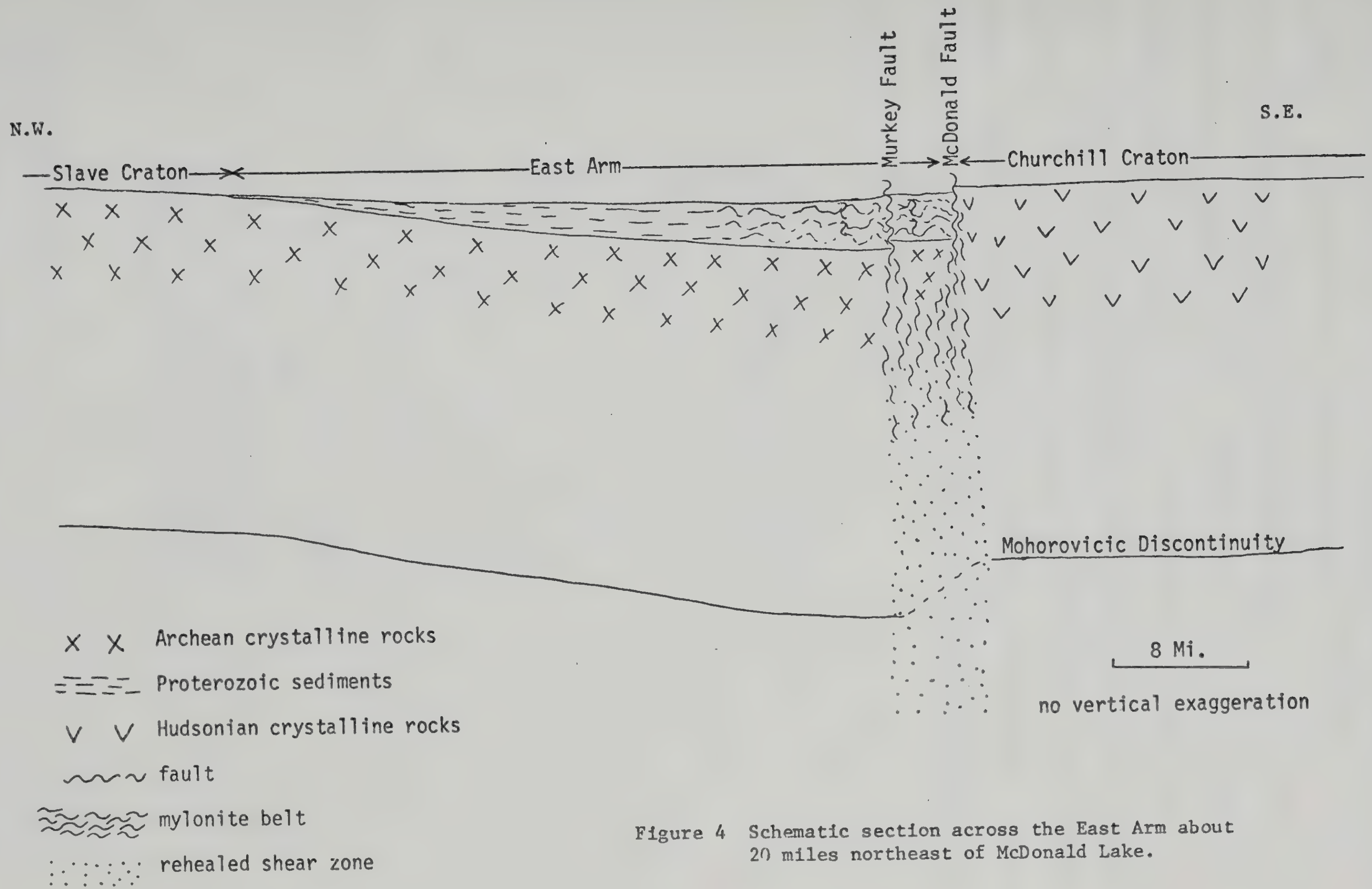


Figure 4 Schematic section across the East Arm about 20 miles northeast of McDonald Lake.

miles across in the middle. It thus attains proportions similar to other major grabens. A seismic crustal study performed in 1966 (Barr, 1971) defined a section across this graben at right angles to the McDonald fault on a line through the most westerly islands in the East Arm. Barr concluded that the crust of both the Slave Province north of the East Arm and Churchill Province south of the East Arm is similar in thickness; approximately 34 km. The crust under the extreme southwest end of the East Arm is, however, about 4 to 5 km thicker and indicates the presence of a graben like structure on the Mohorovicic Discontinuity. Figure 5 presents the crustal profile determined by Barr.

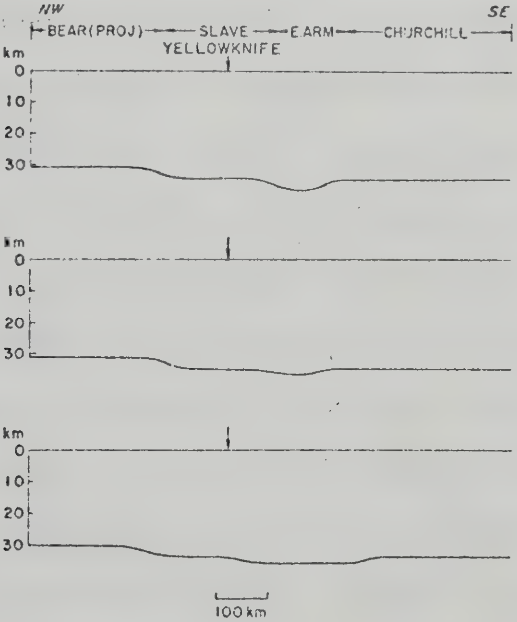


Fig. 5. Crustal profiles through Yellowknife at an azimuth of 130°. The lower profile is derived from the time-term surface (Figure 8), and the two upper profiles are successive approximations (see text). The upper profile is the preferred solution for crustal thickness. From Barr (1971).

Barr concluded that due to the thicker crust under the western East Arm, "we would expect a negative gravity anomaly of about -50 mgal., whereas in fact the East Arm is characterized by a positive gravity

anomaly. This suggests that the lower part of the crust under the East Arm is considerably more dense than elsewhere. Hence the thickness of the crust under the East Arm may be considerably greater than the minimum value quoted" (37.9 ± 0.7 km). A geologic section across the East Arm in the Simpson Islands area is presented in figure 6.

Hoffman (1973) concluded "during the pre-quartzite through dolomite phases of deposition, the aulacogen resembled a graben produced by crustal extension or incipient rifting. The lips of the aulacogen stood high and shed sediment into the trough". However, neither the dolomite-mudstone-submarine basalt sequence of the pre-quartzite phase Union Island Group, nor the dolomite phase Duhamel Formation seem to reflect significant shedding of clastics into the East Arm. The unconformity after deposition, and possibly after folding of the Union Island Group is also inconsistent. The quartzite phase Hornby Channel Formation does represent a thick accumulation of coarse clastics in the East Arm but the character of this formation does not suggest that it was shed from the margins of an enclosing graben. The lateral facies variations from southwest to northeast from coarser and massive crossbedded to finer and thinly bedded with shaley partings combined with the uniform southwesterly directed current indicators (Hoffman, 1969) suggest that the Hornby Channel Formation advanced diachronously up the East Arm from southwest to northeast and that provenance was always to the northeast of the advancing clastic wedge. These features of the Hornby Channel Formation are discussed in more detail in chapter IV.

It may be that the graben present in the southwest one-third of the East Arm developed at the time the carbonate shelf of the Coronation geosyncline foundered and thus gave flysch sediments shed from the orogenic

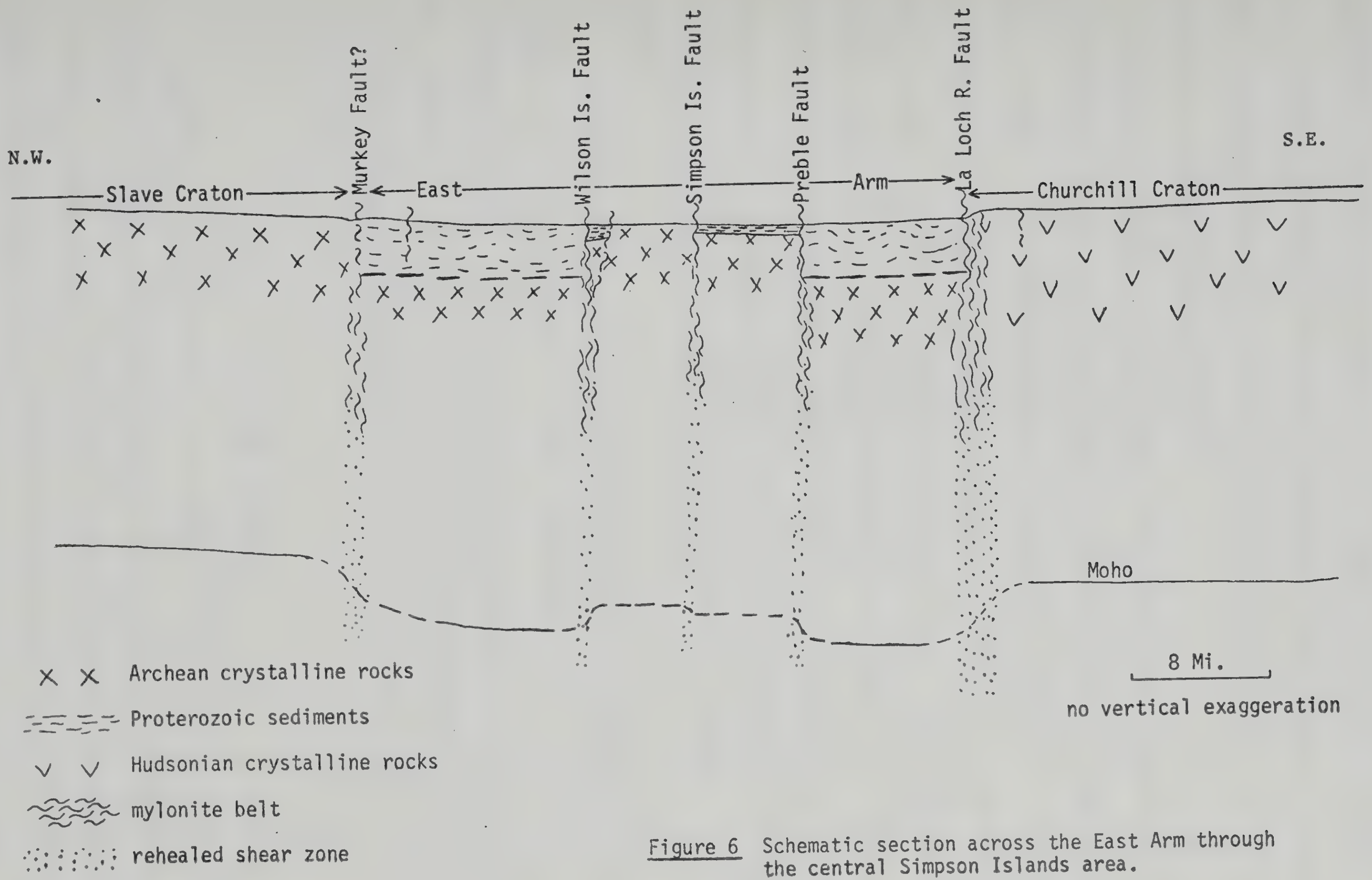


Figure 6 Schematic section across the East Arm through the central Simpson Islands area.

belt access to the East Arm trough. It would not be unlikely for numerous diatremes present on major faults in the southwest end of the East Arm to have formed at the time of graben formation. These diatremes, which definitely postdate the Hornby Channel Formation and probably the Kluziai Formation, are discussed in chapter V.

Following the Hudsonian orogeny and uplift of the Churchill Province, the McDonald system faults and folds in the East Arm were transected by large diabase sills which are locally discordant. The sills are cut by north-northwest striking diabase dykes of the MacKenzie swarm which have been dated at 1315 m.y. (Fahrig and Wanless, 1963). Only minor post-diabase adjustment occurred on the McDonald fault system and this is thought to have been due to normal movement which was post-Devonian, probably Lower Cretaceous, as is evidenced by deformation in Paleozoic cover rocks on fault extensions to the southwest of the East Arm (Douglas, 1959).

A younger set of north-northwest to northwest striking faults is present in the East Arm but is better developed to the north and south, (Reinhardt, 1969a). These faults are steeply dipping, show small sinistral offsets up to several hundred feet in the East Arm and are occasionally occupied by diabase dykes (MacKenzie swarm) or quartz veins (Reinhardt, 1969a, 1969b).

Regional Folding

The Wilson Island Group is the most intensely folded unit of all the Proterozoic strata in the East Arm and this group alone has been affected by readily recognizable, low-grade, regional metamorphism (Reinhardt, 1969b). K-Ar dating of two metamorphic micas (GSC dates 67-74 and 67-75) from this group produced ages of 1785 and 1825 m.y. These dates were interpreted by Reinhardt (in Wanless et al., 1970) as indicative of the

time of metamorphism of the Wilson Island Group. This would suggest that folding was not temporally associated with metamorphism as Great Slave Supergroup rocks unconformably overlie and are much less deformed than the Wilson Island Group. I consider the dates unreliable as they were done on core samples from the site of an abandoned gold-tungsten mine and may well have been updated during a high temperature hydrothermal event or simply as a result of a younger, low-grade metamorphic environment imposed by considerable thicknesses of overlying Proterozoic sediments. It is more probable that folding and metamorphism of the Wilson Island Group was the result of an early Aphebian structural and thermal event which preceded deposition of the Union Island Group and Great Slave Supergroup.

The Union Island Group has been suggested by Hoffman (1968) to paraconformably underlie the Great Slave Supergroup. However, the evidence is equivocal and a closer style of folding present in the Union Island Group may be due to either a second, milder pre-Great Slave Supergroup structural event or to differences in competency between the Hornby Channel Formation and the Union Island Group.

An extensive episode of regional folding occurred following deposition of the Great Slave Supergroup. This folding is largely absent along the north side of the East Arm and becomes progressively more intense towards the McDonald fault bounding the southeast side of the East Arm. The principal axial trend of the folds is east-northeast parallel to the McDonald fault system. Outcrop patterns northeast of McDonald Lake (GSC maps 1122A and 1123A) suggest a second geometric fold axis orientation trending northwest resulting in double plunge on many of the northeast-trending fold axes. Style of deformation within the Great Slave Supergroup varied, dependent in part upon variable competency of the contrast-

ing sedimentary lithologies. In general, the major folds are rather open and upright except adjacent major faults.

A final episode of folding affected the Et-then Group and predated intrusion of MacKenzie swarm diabase dykes. Bedding in the Et-then Group generally dips gently except in proximity to major faults.

Hoffman (1973) has suggested that folding of the Great Slave Supergroup resulted from a sagging stage in the development of the Athapuscow aulacogen. It seems just as plausible that folding was the result of compression between the Slave and Churchill cratons during the Hudsonian orogeny and uplift of the Churchill province.

Fault-Induced Folding

Strata of the Great Slave Supergroup and Et-then Group are commonly much more tightly folded, even overturned, adjacent major faults of the McDonald system than away from such faults. Complex geometry of such fault-proximate folds has been noted in the Simpson Islands area and has also been mentioned by Reinhardt, (1969b). Within the thesis area the very steep dips and tight folding locally observed within the Hornby Channel Formation adjacent the Channel and Simpson Islands faults is atypical of this extremely competent and thick unit of sandstone. This, combined with a lack of features usually associated with tight folding of such rocks, such as flattened pebbles or extensive fold-related joint patterns, suggests that this localized deformation occurred penecontemporaneously with sedimentation. This is further substantiated by soft sediment deformation features and local rapid facies variation as will be discussed in chapter lV. On a regional scale, it appears that folding generated by fault movement was superimposed upon regional fold patterns throughout the south side of the East Arm.

Sub-Et-then Unconformity

The nature of the sub-Et-then unconformity in the Simpson Islands area is of importance in answering the following three questions:

1) What is the scale of normal movement on the McDonald system faults in the Simpson Islands area and can the crustal thickening under this part of the East Arm be accounted for by such offsetting?

2) What was the total thickness of the sediments that once overlay the Hornby Channel Formation in the thesis area and can this be related to burial metamorphism?

3) Was the Hornby Channel Formation in the thesis area exposed to near-surface weathering and groundwater processes immediately prior to deposition of the Et-then Group? This questin is of relevance to the discussion of the genesis of uranium mineralization in chapter VI.

The stratigraphic thickness of the Great Slave Supergroup deposited in the Simpson Islands area was about 30,000+ feet as estimated by Hoffman (1968). In addition to this the Et-then Group was estimated to total about 10,000+ feet. The Preble fault brings the uppermost formation of the Et-then Group in contact with the Hornby Channel Formation on Preble Island. Thus, if the total Great Slave Supergroup section is preserved beneath the Et-then Group a stratigraphic throw of some 40,000 feet on the Preble fault is implied! This situation is considered unlikely as Stockwell's (1936) mapping seems to suggest that the Et-then Group overlies Wilson Island Group and Union Island Group strata on Union Island and Sosan Group strata immediately southeast of Preble Island. Reinhardt's (1969b) mapping indicates that the Et-then Group overlies the Wilson Island Group and the Sosan Group on Wilson Island. It appears likely that the Hornby Channel Formation was exposed in the Simpson Islands area by

erosion prior to deposition of the Et-then Group. This observation permits the following conclusions:

1) The normal movement on the Preble fault was in the order of perhaps 10,000 feet and places the scale of offset in the same order as the scale of crustal thickening in the area.

2) The depth of burial of the Hornby Channel Formation in the thesis area was about 30,000 feet assuming that no major formations were completely removed from the Great Slave Supergroup.

3) The Hornby Channel Formation was likely exposed to weathering and near-surface groundwater processes immediately prior to deposition of the Et-then Group.

Conclusions

The structural evolution of the East Arm is at best difficult to decipher. As a result it is apparent that many comments in this chapter are somewhat speculative. I do not wish to refute Hoffman's (1973) model of the Athapuscow aulacogen, only to suggest that there may be room for modifications or alternatives.

I feel that the East Arm quite likely developed as an extremely long-lived, essentially transcurrent fault system, the basic nature of which may well be more or less independent of the tectonic processes which gave rise to the Coronation geosyncline. There is certainly evidence that a graben-like structure developed at some stage in the western end of the East Arm structural trough but this does not necessarily lead to the conclusion that rifting and graben formation were fundamental, let alone initial, processes in the development of the whole structural trough. There is little doubt that events in the Coronation geosyncline affected sedimentation in the East Arm but this does not imply that the East Arm trough

would not have existed without the Coronation geosyncline. As defined by Salop and Scheinmann (1969), aulacogens are not necessarily spatially related to geosynclines.

It seems possible that the East Arm trough, as controlled by the essentially transcurrent McDonald fault system, was active from the Kenoran to shortly after the Hudsonian orogeny and that deposition (or at least preservation) of the pre-Coronation geosyncline Wilson Island Group was controlled by this structure. The last stage in the evolution of the McDonald fault system, and hence the East Arm structural trough, likely involved movements with a major vertical component which resulted from uplift of the Churchill Province to the south. This converted the transcurrent fault system into a series of fault slices which step up to deeper erosional levels from north to south.

CHAPTER 111

GEOLOGY OF THE THESIS AREA

Introduction

Map 7 presents a summary of the geology of the thesis area. Outcropping within the area are strata belonging primarily to the Hornby Channel Formation which extends the breadth of the major fault block between the Preble and Simpson Islands fault systems. Rocks belonging to the Archean basement complex, the Preble Formation, the Wilson Island Group (?) and the Union Island Group are found peripheral to the Hornby Channel Formation on which economic interest has centered.

Rocks Underlying the Hornby Channel Formation

Archean Crystalline Complex

The Archean rocks unconformably underlying and faulted against the Hornby Channel Formation are predominantly granitic and paragneissic rocks of the Katazone. The gneissic rocks are for the most part garnet-biotite gneiss ± sillimanite and cordierite. The gneisses underlying most of the exposed basement on South Simpson Island generally contain less than 20% mafics whereas mafic-rich, pelitic gneisses and migmatites were observed north of the west end of Vestor Channel. Most of North Simpson Island is underlain by granitic to granodioritic rocks of plutonic aspect with smaller amounts of granite gneiss. In general, the metamorphic foliation dips gently to moderately northeast with uncommon small-scale folds. The Archean rocks are commonly transected by granitic pegmatites, many of which are undoubtedly migmatic in genesis. Ubiquitous post-Kenoran diabase dykes transect the Archean complex.

Wilson Island Group (?)

On the south side of South Simpson Island, in the vicinity of Preble

Channel, a thin, wedge shaped fault block is underlain by tightly folded quartzite, siltstone, shale, dolomite and volcanics which have been tentatively ascribed to the Wilson Island Group. Stockwell, (1936) mapped these rocks as well as adjoining Archean granite and gneissic rocks as Wilson Island Group but Reinhardt (1972) remapped the fault wedge as brecciated basal Hornby Channel Formation sediments. Although the rocks in question may possibly belong to the Union Island Group, it seems unlikely that they belong to the Great Slave Supergroup.

Union Island Group

North of Ref Peninsula on North Simpson Island is a small area of near vertically dipping, interbedded red shale and non-stromatolitic dolomite which is considered Union Island Group by virtue of lithologic similarities and because the sequence unconformably overlies Archean basement. No lithologically similar rocks in the Great Supergroup are known to overlie the basement unconformity. This outcrop becomes the most westerly occurrence of Union Island Group recorded and lies eight miles southwest of the closest Union Island Group rocks mapped by Stockwell (1936). Hornby Channel Formation sandstone is juxtaposed with these rocks across the Simpson Islands fault.

Structure

The sandstones of the Hornby Channel Formation which outcrop in the thesis area, extend the full width of the fault block between the Simpson Islands fault system and the Preble fault. The area is not considered a syncline but rather a wedge of sandstone dipping 10° to 15° to the northeast which has suffered fault generated local folding along the bounding fault system. Thus bedding strike abruptly swings parallel to the major faults along the northwest and southeast sides of the fault block and

bedding has commonly been moderately to steeply tilted adjacent the northeast striking faults. Away from such major faults the bedding shows only very gentle undulations and shallow dips.

The planes of northeast striking faults are characterized by protomylonite, mylonite, brecciated mylonite, mylonitic quartz veins and giant quartz veins containing clasts of mylonite, sandstone and granitic rocks. The faults are linear and commonly splay at points of inflection.

Northwest striking faults of minor sinstral displacement were only rarely observed and are marked by very narrow gouge or breccia seams. A diabase dyke cutting Susanne Peninsula occupies a northwest fracture. Prominent air photo lineations on Ref Peninsula (map 7) probably reflect the presence of diabase dykes (covered by overburden) which similarily intruded north-northwest trending fractures.

Within the thesis area, three, steeply dipping, diffuse sets of joints have been identified transecting the sandstones of the Hornby Channel Formation. The most prominent set of joints present in the area strikes east-southeast and is consistent with the orientation expected of the conjugate shear to the northeast-striking dextral faults. This set is best developed near major northeast faults. Northeast to east-northeast striking joints parallel the major faults. Both of the above joint sets are likely genetically related to the McDonald system faults. A less well developed set of north-northwest to northwest striking joints parallels the younger and rarer sinstral faults previously described.

Age of the Hornby Channel Formation

The Hornby Channel Formation, as part of the Great Slave Supergroup, has long been known to be Aphebian in age. The key to precise dating of the Formation rests in the age and field relations of a large albite

syenite dyke which lies along a portion of the northern limit of Hornby Channel Formation exposure on North Simpson Island (see map 7). This dyke was first included by Stockwell (1936) as one of the series of dioritic bodies which intrude most formations of the Great Slave Supergroup (Hoffman, 1968). Subsequent K/Ar dating has shown the series of dioritic intrusions to be about 1800 m.y. old (Hoffman, 1969) whereas two K/Ar (biotite) dates on the dyke in question produced ages of 2170 m.y. (GSC date 62-93) and 2200 m.y. (Burwash and Baadsgaard, 1962). Although Burwash and Baadsgaard (1962) proposed that the dyke postdated the Hornby Channel Formation and that deposition of the Great Slave Supergroup took place between 2480 m.y. and 2200 m.y. ago, Reinhardt (1969b) concluded that, "nowhere could this dyke be found cutting the Sosan Formation (Great Slave Supergroup)". Hoffman, et al. (1970) suggested a probable maximum age of the Hornby Channel Formation of 2000 m.y. based on a time-stratigraphic reconstruction, assuming Great Slave Supergroup deposition rates to be similar to those in Phanerozoic orthogeosynclines. This reconstruction supported Roscoe's (1969) conclusion that the Great Slave Supergroup is younger than the Huronian succession which is known to be greater than 2150 m.y.

Detailed mapping along the dyke (map 8) revealed a small outcrop northeast of Dyke Lake and adjacent the syenitic dyke, where sandstone of the Hornby Channel Formation has been mildly brecciated and intruded by albite syenite indistinguishable from that of the dyke which lies 100 feet away across an overburden covered fault. It is this covered fault which runs along the contact between the dyke and the Hornby Channel Formation that has obscured their field relations for so long. Partial cataclasis has been superimposed upon the breccia and has resulted in only partial preservation of a coarse grained albite syenite phase between clasts of

sandstone. Further evidence for a younger age of the dyke is provided by a 2 x 18 inch sandstone xenolith found isolated within the massive syenite dyke north of the contact fault. The sandstone of the xenolith appears identical to that of the Hornby Channel Formation adjacent the dyke while no sedimentary rocks underlie the Hornby Channel Formation in this area.

This evidence suggests that deposition of the Great Slave Supergroup began before about 2185 m.y. ago and reopens the possibility that it may be as old as the Huronian succession of Ontario. The writer does, however, tend to agree with the sedimentological arguments of Roscoe (1969) that indicate the Lower Huronian is probably older. It would seem more likely that the Wilson Island Group, lacking stromatolitic dolomite and red-beds, is time stratigraphically equivalent to the Elliot Lake Group, (Lower Huronian) whereas the Great Slave Supergroup shows affinities with the Cobalt Group (Upper Huronian).

The 2185 m.y. minimum age of the Hornby Channel Formation is also significant in that, assuming the stratigraphic correlations of Hoffman, et al. (1970) are correct, it implies a minimum age for the Odjick and Western River Formations of the Epworth and Goulburn Groups respectively. One problem that does arise is the implied invalidity of the time stratigraphic reconstruction of Hoffman, et al (1970). If sedimentation rates during Coronation Geosyncline times were similar to those of Phanerozoic geosynclines an internal paraconformity or unconformity is necessary within the Great Slave Supergroup to account for about 200 m.y. of geologic history. Such a possible unconformity has been proposed by Hoffman (1968) above the Duhamel Formation, however, no such unconformity has been recognized in either the Epworth or Goulburn Groups. Rb/Sr dating of the dyke would lend authority to the minimum age of the Hornby Channel Formation.

A maximum age for the deposition of the Hornby Channel Formation

must be substantially less than the end of the Kenoran Orogeny since deposition of the Wilson Island Group (15,000 + feet) and Union Island Group (3000 + feet) preceded the Hornby Channel Formation. Abundant east-northeast trending diabase dykes cut the basement but do not intrude the overlying Hornby Channel Formation. Due to poor exposures of the unconformity no such dykes have actually been seen to be directly overlain by the Hornby Channel Formation however an aeromagnetic anomaly associated with such a dyke swarm in the basement west of Paddlefish Bay is rapidly attenuated over the sandstone to the east of the unconformity. This suggests that some of the east-northeast striking diabase dykes predated the Hornby Channel Formation. A few east-northeast striking diabase dykes transect the large albite syenite dyke which runs along the north side of the thesis area. As the albite syenite dyke postdated the Hornby Channel formation, it appears likely that east-northeast striking diabase dykes were intruded both before and after deposition of the Hornby Channel Formation. East-northeast striking diabase dykes have not been dated in the East Arm but Fahrig and Wanless (1963) obtained a 2165 m.y. age, based on three K/Ar dates, of east-northeast striking diabase dykes 100 miles northeast of the thesis area.

Burial Metamorphism

Great Slave Supergroup sediments have been described as unmetamorphosed (Hoffman, 1968, 1969; Hoffman et al., 1970). Within the thesis area the Hornby Channel Formation is almost exclusively sandstone, with variable amounts of sericitic matrix, in which the effects of very low-grade metamorphism are not readily apparent. However, an unusual unit of sandstone, rich in volcanic debris, which outcrops near the northeast end of base line 1 (map 10) does indicate that the sediments were subjected

to very low-grade metamorphism which is not discernible on the basis of examination of the common Great Slave Supergroup sediments. The volcanic sandstone contains up to 50% highly altered volcanic debris which appears to have been initially glassy. Most of the volcanic material has been altered to spherulitic aggregates of chlorite plus sericite, carbonate, prehnite, pumpellyite and albite. Like much of the chlorite, the pumpellyite and prehnite are typically arranged in close-packed spherules suggesting replacement of original glass or pumice (plate 4f). This mineral assemblage is indicative of the pumpellyite-prehnite-quartz facies of burial metamorphism and suggests that the sediments were subjected to temperatures in the order of 250° to 350°C (Liou, 1971).

As discussed in chapter II, stratigraphic and structural evidence indicates the Hornby Channel Formation in the Simpson Islands area was covered by at least 30,000 feet of overlying strata prior to the Hudsonian orogeny. A rather normal geothermal gradient of about 30°C/Km would be sufficient to produce a temperature of about 300°C at this depth and hence the basal Great Slave Supergroup throughout the western East Arm was likely subjected to similar subgreenschist facies metamorphism. Similar prehnite rich volcanic sandstone of the Hornby Channel Formation was mapped by the writer on islands in Inconnu Channel about thirteen miles west of the base line 1 occurrence. The stratigraphic height to which zeolite and pumpellyite-prehnite-quartz facies metamorphism extended would be in part controlled by the erosional depth reached by the sub-Et-then Group unconformity and in part by the thickness of Et-then and post Et-then sediment (much of which has been subsequently eroded). Due to stratigraphic thinning towards the northeast (Hoffman, 1968) one would expect a decrease and eventual disappearance of regional metamorphic effects towards the northeast end of the East Arm. Continued stratigraphic thickening of the Great Slave

Supergroup towards the southwest would soon introduce greenschist facies metamorphism towards the region supposed by Hoffman et al. (1970) to be underlain by the Coronation geosyncline orogenic belt.

Detailed Geologic Mapping

General

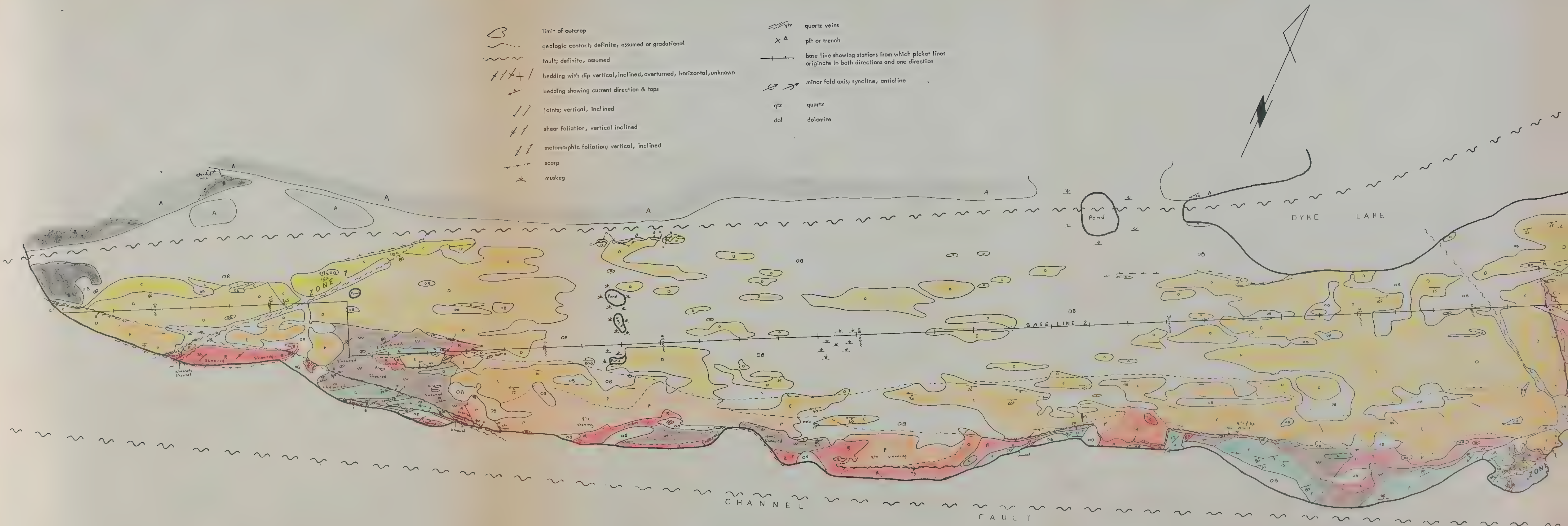
The areas encompassed by base lines 1 and 2 (see map 7 for location) were geologically and radiometrically mapped on a scale of 1 inch to 200 feet (maps 8 through 11). These maps provide the detailed geological base in the area of primary economic interest as they include seven of the ten radioactive zones and all important uranium occurrences known on the Simpson Islands property of Vestor Explorations Ltd. They also cover the most geologically complex area within the property as they lie along the Simpson Islands fault system and exhibit the effects of local facies variation, structural deformation, metasomatism and intrusion by bostonite stocks and diatreme breccia pipes. All lithologic units mapped on the two base lines will be described below. Information draws on field data from surface and from 9000 feet of diamond drill core examined by the writer as well as the study of approximately 150 thin sections, most of which were stained for both feldspars.

Selected areas mapped in varying detail will be dealt with individually following discussion of the two base line maps.

Base Line 2 Lithologic Descriptions

Basement (Slave Structural Province)

A. Granite, granite gneiss and granodiorite gneiss: The granite and granite gneiss are pink to white and carry muscovite and biotite. The granodiorite gneiss is generally white with up to several percent biotite. Occasionally garnet and sillimanite are present.


limit of outcrop
geologic contact; definite, assumed or gradational
fault; definite, assumed
bedding with dip vertical, inclined, overturned, horizontal, unknown
bedding showing current direction & tops
joints; vertical, inclined
shear foliation, vertical inclined
metamorphic foliation; vertical, inclined
scarp
muskeg
quartz veins
pit or trench
base line showing stations from which picket lines originate in both directions and one direction
minor fold axis; syncline, anticline
qtz
quartz
dol
dolomite
DYKE LAKE
BASE LINE 2
CHANNEL
FAULT
ZONE 1
ZONE
Pond
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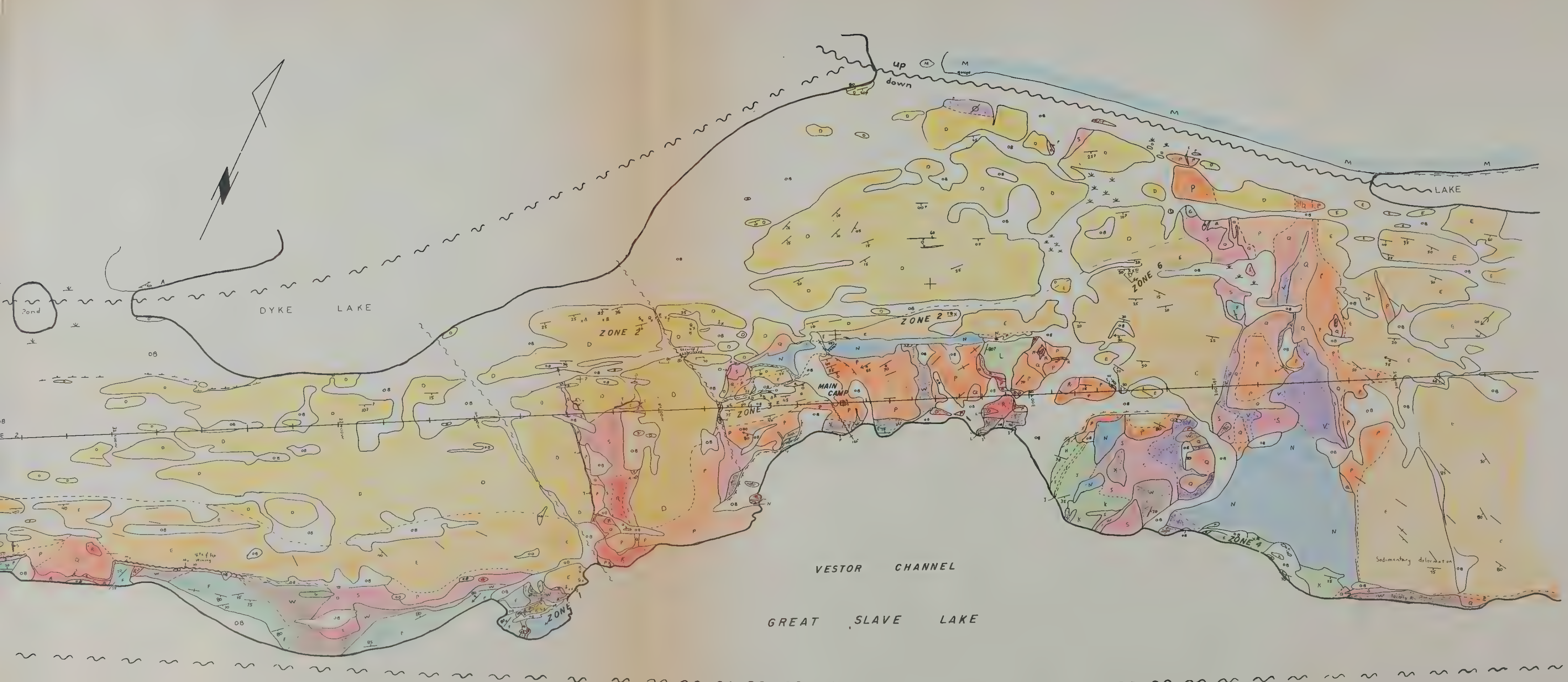


BASEMENT (Slave Structural Province)

- ☐ A Granite, granite gneiss & granodiorite gneiss - sillimanite grade
- ▨ B Paleoregolith

HORNBY CHANNEL FORMATION (Aphebian)

- ☐ C Silicified, fine orthoquartzite
- ☐ D Sericitic, subfeldspathic to feldspathic, slightly conglomeratic sandstone
- ☐ E Silicified, sericitic, conglomeratic sandstone

APHEBIAN STRATA OF UNCERTAIN STRATIGRAPHIC POSITION

- ☐ F Grey to black siltstone with smaller amounts of black and red shale, dark brown shale and siltstone, red siltstone, very fine to medium grey sandstone, marl and minor buff weathering dolomite interbeds.
- ☐ G Dolomite
- ☐ H Dark brown shale
- ☐ I Pellitoid chert
- ☐ J Dark red, micaceous, fine sandstone to siltstone
- ☐ K Brown, silicified subfeldspathic, micaceous sandstone
- ☐ L Boulder diamictite

INTRUSIVE ROCKS

- ☐ M Red albite syenite
- ☐ N Red-brown bostonite
- ☐ O Breccia dykes with albitized comminuted matrix predominant

BRECCIATED AND ALLOCTHONOUS LITHOLOGIES

- ☐ P Stage 1 brecciated sandstone
- ☐ Q Stage 2 sandstone breccia
- ☐ R Stage 3 breccia; extremely variable clasts in siltstone matrix
- ☐ S Dolomitized, albitized, stage 3 breccia with siltstone and comminuted matrix
- ☐ T Dolomitized, banded microbreccia; intrusive
- ☐ V Brecciated bostonite
- ☐ W Brecciated and/or sheared siltstone
- ☐ X Brecciated dolomite
- ☐ Y Brecciated, fine, red, micaceous sandstone
- ☐ Z Qua.tz/mylonite veins
- ☐ 0 Sandstone/syenite breccia

OB Overburden; till & raised beaches

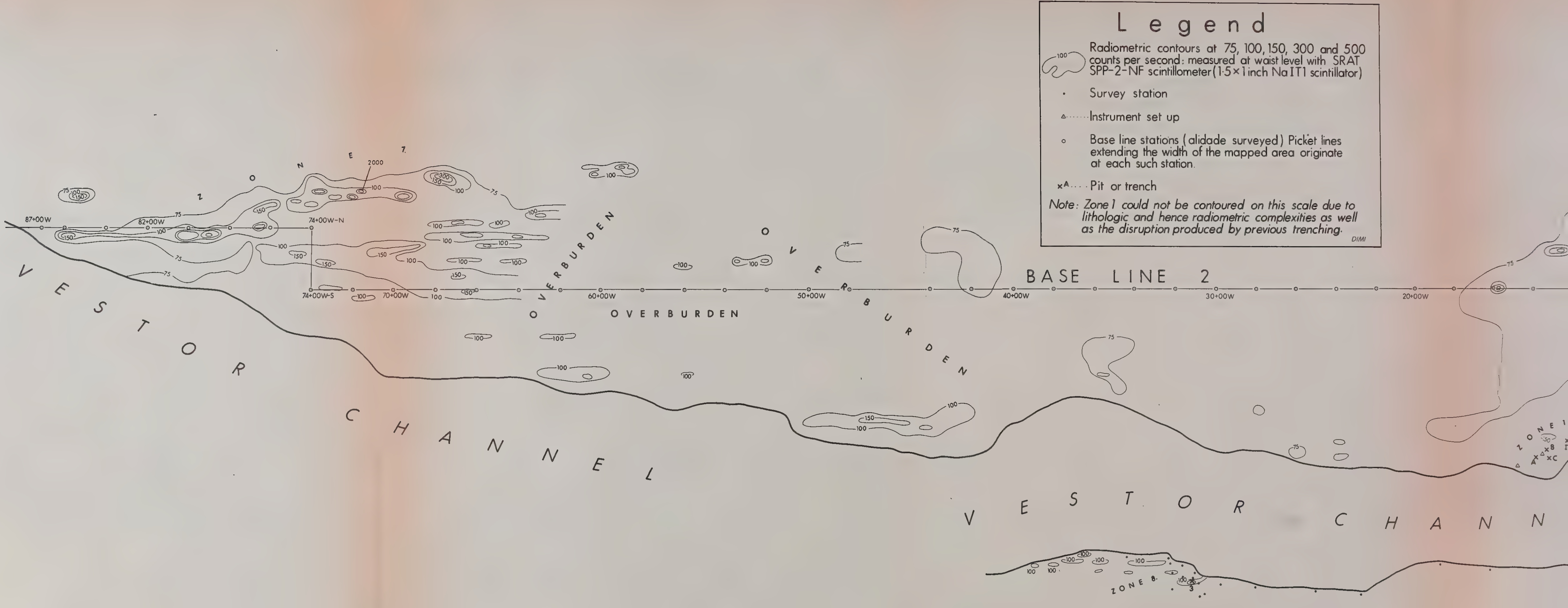
MAP 8

GEOLOGY OF BASE LINE 2.

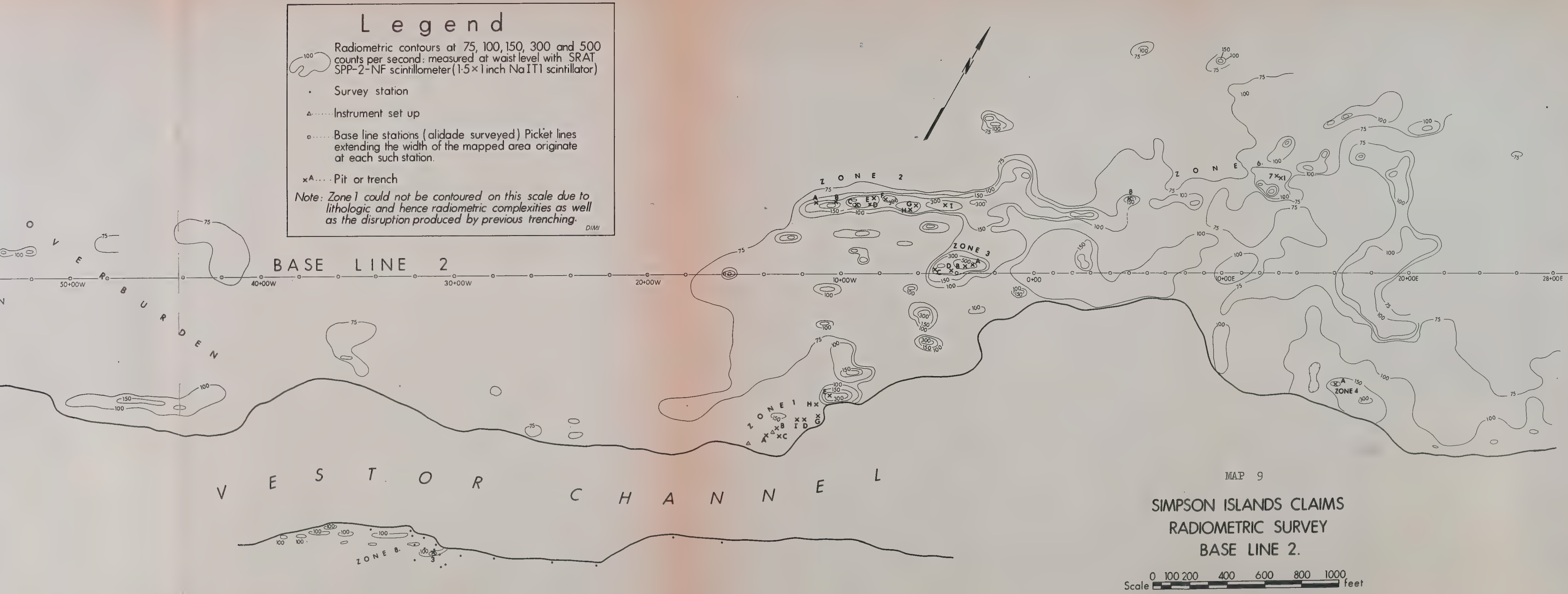
Simpson Islands Claims

SCALE 0 100 200 300 400 500 Feet

R. Walker July, 1971.


Legend
Radiometric contours at 75, 100, 150, 300 and 500 counts per second: measured at waist level with SRAT SPP-2-NF scintillometer (1·5×1 inch NaIT1 scintillator)
Survey station
Instrument set up
Base line stations (alidade surveyed) Picket lines extending the width of the mapped area originate at each such station.
×A Pit or trench
DIMI
ZONE 7
2000
87+00W
82+00W
74+00W-N
74+00W-S
70+00W
60+00W
50+00W
40+00W
30+00W
20+00W
BASE LINE 2
OVERBURDEN
OVERBURDEN
OVERBURDEN
VESTOR CHANNEL
VESTOR CHANN
ZONE 8
ZONE 1
xB
xC
75
100
150
300

Note: Zone 1 could not be contoured on this scale due to lithologic and hence radiometric complexities as well as the disruption produced by previous trenching.


Legend
Radiometric contours at 75, 100, 150, 300 and 500 counts per second: measured at waist level with SRAT SPP-2-NF scintillometer (1·5×1 inch Na I T1 scintillator)
Survey station
Instrument set up
Base line stations (alidade surveyed) Picket lines extending the width of the mapped area originate at each such station.
Pit or trench
Note: Zone 1 could not be contoured on this scale due to lithologic and hence radiometric complexities as well as the disruption produced by previous trenching.
DIMI
OVERBURDEN
BASE LINE 2
50+00W
40+00W
30+00W
20+00W
10+00W
0+00
10+00E
20+00E
28+00E
ZONE 1
ZONE 2
ZONE 3
ZONE 4
ZONE 6
ZONE 8
VESTOR CHANNEL
75
100
150
300
500
Scale 0 100 200 400 600 800 1000 feet

MAP 9

SIMPSON ISLANDS CLAIMS
RADIOMETRIC SURVEY
BASE LINE 2.

Pink, granitic, muscovite pegmatites cut all basement rocks except occasional northeast-striking diabase dykes.

B. Paleoregolith: Strongly altered granitic rock in which all mafics (except muscovite) and much or all feldspar are altered. The predominant alteration product is pale green sericite (plate 4a). In extreme cases the sericite forms a matrix for poorly packed quartz grains (plate 4b) and hence is transitional into extremely sericitic sandstone although no such gradation is seen in the field. This rock type commonly contains blocks (several inches to a few feet across) of less altered granitic material similar to those described in the sub-Huronian granitic paleoregolith (Roscoe, 1969). This lithology commonly appears sheared and is friable in surface exposures due to recent weathering. Contacts with unaltered granitic rocks are gradational over several tens of feet on the present erosion surface but the total stratigraphic thickness of the unit is thought to be no more than a few tens of feet normal to the overlying unconformity. Where exposed and in drill core the unconformity is a sharp contact between paleoregolith and unit C.

Hornby Channel Formation (Sosan Group)

C. Silicified orthoquartzite: White, reddish, buff, well-sorted, well-rounded, silica-cemented, fine- to medium-grained, greater than 95% quartz. This lithology usually appears at the base of the Hornby Channel Formation and varies in thickness from 0 to about 60 feet. The irregular thickness of the unit is likely due to the irregular basement erosion surface on which it was deposited. With rare exceptions this lithology is massive and it probably represents aeolian

sands or possibly a mature beach deposit. Occasional lenses of this lithology occur in the overlying unit D. Both upper and lower contacts are sharp.

D. Sericitic, subfeldspathic to feldspathic, slightly conglomeratic sandstone: Light brown to buff, locally reddish due to hematite staining, pale green when fresh. Well sorted, locally poorly sorted, subrounded to rounded. Generally less than 5% granules and pebbles which are quartz, metaquartzite, sandstone, siltstone and chert or mylonite with granitic and altered granitic pebbles common towards the base of the unit. Grain size is medium to coarse and feldspar comprises 10 to 30%. Cementing is by contact silica cement and porosity occluding, recrystallized, pale green sericite cement. Sericite constitutes 10 to 25% of the rock and is responsible for the buff to brown color on weathered surfaces. The sericite imparts a light green color to fresh surfaces. This rock is generally very massive and hematite laminations and cross bedding are extremely rare. This unit reaches 700 to 800 feet thick. Drill core has shown this unit to contain occasional green mudstone (recrystallized sericite) lenses and chips that appear tectonically squeezed. Occasional ferruginous and micaceous (detrital muscovite) siltstone lenses up to a couple of tens of feet thick were intersected in drill core but are not exposed on surface. The upper contact (with unit E) is ill-defined and gradational over several tens of feet.

E. Silicified, sericitic, conglomeratic sandstone: This lithology is quite variable over short distances both along and across strike. In general it is white to buff, locally reddish due to matrix hematite staining and occasionally pink due to hematite staining of feldspars only. It is medium to very coarse with up to 50% granules

and pebbles while sorting is generally only fair but quite variable. Usually gravel comprises a few to 20% of the rock with granules predominant. The gravel fraction is oligomictic, composed of quartz and metaquartzite with rare chert (recrystallized siliceous mylonite ?) clasts. Detrital feldspar content ranges from a few to 30%. Cementing is by silica contact and overgrowth cement and interstitial recrystallized sericite which imparts a pale green color to the rock when fresh. This lithology is more strongly cemented and whiter than unit D which is likely due to less sericite (in the order of several percent less) and more silica cement. Abraded, inherited quartz overgrowths are occasionally present on larger quartz grains. Hematite sand and grain size laminations are ubiquitous and often define extensive festoon cross-beds (plate 1a). Such cross-bedding often gives biased strike and dip measurements, a problem compounded by an almost complete lack of bedding planes. Internal scour surfaces are prevalent in this unit. No upper contact is seen and this is the highest established stratigraphic level of the Hornby Channel Formation mapped on base line 2.

Aphebian Strata of Uncertain Stratigraphic Position

F. Grey to black siltstone with smaller amounts of black and red shale, dark brown shale and siltstone, red siltstone, very fine to medium grained grey sandstone, marl and minor buff weathering dolomite: Dark grey, quartz-feldspar-sericite-chlorite siltstone comprises about 80% of the map unit. It is laminated to thinly bedded (maximum thickness of a few feet). Beds are commonly graded from massive, very fine sand at the base through massive dark grey siltstone to cross-laminated and ripple marked siltstone (with or without convolute

bedding) and with a thin (few millimeters) shaley top. Due to grading and zonation of sedimentary structures such beds resemble distal turbidites. Some soft-sediment deformation due to compaction, water escape and downslope movement is locally in evidence. The siltstone commonly contains specular hematite and red (hematized) albite veinlets and is locally red due to hematite staining. The siltstone grades into shale on the one hand (black, red and dark brown) and very fine- to medium-grained, sandstone interbeds were noted in the area of 100+00W, 9+00S. Dolomite interbeds up to a few feet thick in the dark grey siltstone have been included in this map unit. The dolomite is described below and is associated with marly siltstone and shale. Contacts between this unit and the Hornby Channel Formation are all faulted or intrusive and brecciated.

G. Dolomite: Pink, white, grey, buff and purplish on fresh surface, light brown on weathered surface. The dolomite is compact with irregular thin (1 mm) siliceous veinlets commonly forming a close network. Locally, siliceous laminations are present. The dolomite is commonly laminated and ripple-marked with cross-ripple laminations. The dolomite appears to have been deposited in shallow water as a fine sand and is nowhere definitely stromatolitic although in places laminations might be interpreted as cryptalgal. The dolomite always occurs interbedded in dark grey siltstone and the sequence likely represents a marine environment of shallow depth. The dolomite has been recrystallized to a microcrystalline mosaic of anhedral dolomite grains with local patches recrystallized to medium to coarse white dolomite. Almost all dolomite has been fractured in an early stage of breccia development with fractures typically infilled

by coarse crystalline white dolomite. No sedimentary contacts with the Hornby Channel Formation could be found.

H. Dark brown shale: This rock type commonly occurs in association with lithology J, and is nowhere seen in sedimentary contact with Hornby Channel Formation.

I. Pelletoid chert: This rock is composed of well sorted, oblong, pellet-like bodies of chert about 0.5 mm across cemented by interstitial chalcedony (plate 4e). The dark red color of this rock is the result of extensive hematization which locally has completely replaced the pellet-like chert bodies. Spherical, white chalcedony and carbonate bodies 3 to 8 mm across are locally abundant (up to 50%) especially towards one contact and appear to replace the pelletoid host. This rock occurs as a four foot thick interbed with sharp contacts in unit J in an area of allocthonous rocks at 8+00E, 4+50S. The origin of the rock is enigmatic as it most closely resembles an accumulation of fecal pellets although its probable Aphebian age seems to preclude such a genesis.

J. Dark red, micaceous, fine sandstone to siltstone: Well sorted, strongly hematite stained, feldspathic, few to several percent fine to medium grained detrital muscovite flakes are oriented parallel to the bedding. The unit is massive to laminated. Although a similar rock type occurs within the Hornby Channel Formation on base line 1, this map unit is considered allocthonous and of a formation other than the Hornby Channel Formation.

K. Brown, silicified, subfeldspathic, micaceous sandstone: Well sorted, fine to medium grained, brown to buff on weathered surface, buff to pale green on fresh surface, 10 - 15% feldspar. Minor, medium grained detrital muscovite is common and occasional, fissile, green muscovite

rich (5 to 15%) sandstone lenses up to a few feet thick are present. The greenish color is undoubtedly imparted by sericite cement. This rock type occurs along Vestor Channel between 10+00E and 20+00E and is not seen in contact with sandstones definitely of the Hornby Channel Formation. This unit may well be part of the Hornby Channel Formation but because all contacts are with intrusive or allochthonous rocks it is considered to be of uncertain stratigraphic position. The rock has been subjected to fracturing and mild brecciation as described under unit P and as such should be considered as a stage 1 brecciated sandstone.

L. Boulder Diamictite: This is a matrix-rich conglomerate with a disrupted framework. It is composed of 40 to 50% well rounded lithic pebbles, cobbles and boulders mostly of granite, gneisses, sandstone, siltstone, dolomite and shale in a dark grey matrix of dirty, silty sand of all sizes. The rock is extremely heterogeneous and unsorted. It is found in association with brecciated lithologies and is not likely part of the Hornby Channel Formation. Lithologically it resembles conglomerates of the Murky Formation (Et-then Group) although such a correlation is not justified on the basis of available evidence. Reinhardt (1972) has described this rock type as a pseudoconglomerate generated by diatreme activity. The evidence for or against this hypothesis is circumstantial and one cannot be conclusive about the genesis of this unit.

Intrusive Rocks

M. Red albite syenite: This is a coarse, hypidiomorphic granular, dyke rock composed of 80 to 90% antiperthitic albite, 10 to 20% mafics, minor potassium feldspar and up to a few percent acicular apatite. The albite contains 5 to 8% anorthite as indicated by both refractive

index and extinction angle measurements. This albite is antiperthitic (perhaps 15% of the feldspar is potassic) and weakly altered to sericite and epidote. The megascopic red color is due to a microscopic dusting of heamtite through the albite. The mafic component comprises carbonate-magnetite-chlorite-hornblende pseudomorphs of euhedral pyroxene, deuteric (?) hornblende, and extremely pleochroic primary biotite. This unit comprises a dyke up to a few hundred feet thick that forms part of the north boundary of the map area. A fault coincides with the southern contact of the dyke within the map area and locally, adjacent the fault, all mafics have been altered to a pale green mass and the rock shows evidence of weak shearing. In one location gouge is present adjacent the fault.

N. Red-brown bostonite: Before alteration this rock was composed of 95% albite (An_6), trace to minor quartz, up to 10% acicular apatite and up to 10% magnetite. The texture is idiomorphic to hypidiomorphic with an imperfect trachoidal arrangement of albite laths (plate 4c). Albite laths are less than 2 mm in length with equidimensional albite phenocrysts rarely present. Alterations include hematization, sericitization, carbonatization and chloritization. A fine dusting of hematite throughout the albite produces the characteristic red-brown color on both weathered and fresh surfaces although locally a dark grey phase is present which is petrographically identical to the reddish bostonite. Sericitization has affected the bostonite to varying degrees from only a minor alteration of albite to complete replacement. In outcrops, secondary sericite comprises less than about 10% whereas in drill core certain contact zones and thin dykes are completely altered to pale green sericite plus dolomite over widths of up to several feet.

Dolomitization of the bostonite is ubiquitous with replacive dolomite constituting 20 to 60% of the rock. In addition to this, some outcrops show a close network of coarse crystalline white dolomite veinlets of all orientations which in themselves may comprise several percent of the exposure (plate 3a). Chlorite content varies from trace to 25% with high chlorite contents only seen in the large intrusion at 17+00E, 5+00S and in drill core from 3+00W, 0+00N. It is thought that most, if not all, of the chlorite was introduced as evidence for replacement of mafics is lacking whereas evidence for replacement of albite is common. The bostonite has been extensively brecciated in many areas during diatreme activity and this map unit is gradational into unit V, brecciated bostonite. Thin section study has revealed that some areas mapped as massive bostonite are in fact composed of bostonite clasts in a comminuted and recrystallized albite matrix.

O. Breccia dykes with albitized comminuted matrix predominant: This lithology is composed of 20 to 70% fragments of quartz, feldspar, sandstone, and granitic rock locally with bostonite, siltstone and microcrystalline dolomite set in a very finely comminuted, quartzo-feldspathic matrix which has undergone partial recrystallization, extensive to complete albitization and partial dolomitization (plates 5 & 6). The megascopically visible clasts are lithic, range up to a few inches across and are sub-rounded to rounded. Microclasts are predominantly single crystal fragments of much greater angularity. Most quartz microclasts are preserved whereas potassium feldspar grains which escaped albitization are very rare. The matrix is composed of a mosaic of albite (60 to 90%) and quartz (10 to 40%)

which occurs as equidimensional grains usually about 0.015 mm across but which range from 0.008 to 0.04 mm (plate 6d). It is usually structureless but occasionally preferred orientation of elongate clasts and porphyroblasts define a weak flow structure indicative of movement of matrix between clasts (plate 5c). This texture is not the banded structure typical of mylonites as it is not thought to have been generated by shearing due to directed stress (Higgens, 1971). The matrix is salmon pink in hand sample due to the invariable weak hematization of albite. The matrix is usually noticeably sericitic and in some samples long straight muscovite porphyroblasts comprise up to 10% of the matrix (plate 5g). Quartz porphyroblasts are almost always present in amounts up to 30% of the matrix. They are commonly euhedral (alpha-quartz morphology), radiating and zoned (plate 5; d,e & f) and range up to several tenths of a millimeter across. Similarily more coarsely crystalline albite is present in veinlets or as patches (plate 6, a to d). Occasional, scattered, isolated, lath-shaped albite porphyroblasts up to 0.5 mm are present in amounts up to 10% of the matrix (plate 5h). Only the coarser albite shows twinning which is usually a poorly developed chess board variety. Coarse, secondary, replacive dolomite, commonly as euhedral rhombs (sometimes zoned), was the last mineral to crystallize. It is preferentially replaces the albitic matrix but may affect clasts (particularily siltstone) to a lesser degree. Carbonate composes 5 to 30% of the total rock and its preferential leaching commonly imparts a "scoriaceous" appearance to the outcrop surface. This rock type occurs as dykes up to a few feet across that locally bifurcate and have sharp contacts. They are definitely intrusive and their close resemblance to aplite was the reason for their inclusion with intrusive rocks during

field mapping. This unit is transitional into unit Q and V on the one hand and unit S on the other. Many outcrops of this rock were too small to map as such and hence were included within units Q, S and V.

Brecciated and Allochthonous Lithologies

P. Stage 1 brecciated sandstone: This unit is composed of sandstone (usually of unit E) that has been involved in an initial phase of brecciation which resulted in irregular fracturing with fracture spacing varying from a few inches to several feet (plate 2a). Fractures vary in width up to about 1 cm and some are complex breccia seams up to a couple of feet across containing disoriented fragments of sandstone (plate 2b). Fractures are infilled by one or more of the following materials:

i) comminuted and albitized rock material which basically is the same as the matrix for lithology O except that it is generally less recrystallized and dolomitized and rarely shows more coarsely crystalline patches of secondary albite.

ii) coarse crystalline, white dolomite

iii) coarse crystalline, white quartz which is commonly drusy

In general the rock in a stage 1 breccia has been fractured but not extensively fragmented and there appears to have been little movement of sandstone blocks outside of local jumbling which disoriented bedding across fractures. The contacts of this unit with unbrecciated sandstone and stage 2 sandstone breccia (unit Q) are usually gradational over distances up to several tens of feet. Contacts with other rock types are abrupt and brecciated.

Q. Stage 2 sandstone breccia: In this unit the sandstone has been shattered into distinct angular fragments, usually less than several feet across, set in a matrix of aphanitic, comminuted, partially recrystallized, albitized, weakly hematized and partially dolomitized quartzo-feldspathic material the same as the matrix in unit O (plate 2c). Locally, especially towards the west end of the base line, coarse crystalline quartz cement is important. The matrix generally comprises less than 30% of the rock and as little as 10%. Juxtaposition of contrasting sandstone lithologies as well as disorientation of bedding between blocks is indicative of transport and some mixing of fragments. This unit is gradational with unit P on the one hand and units O, S and R on the other. Contacts are always with another breccia lithology; however, some transitional units were too small to map.

R. Stage 3 breccia; extremely variable clasts in siltstone matrix: Breccias mapped in this unit are highly variable both in amount and in composition of fragments but all are characterized by an abundance of deformed, dark grey to black siltstone matrix (plate 2; d to h). The fragments (not including siltstone) vary from several to about 80% and include all sandstone types, dolomite, siltstone, shale and bostonite as well as rare pelletoid chert clasts. Usually the breccias have a disrupted framework and fragments range in size up to at least 150 feet across. In general fragments are angular but locally noticeable rounding is in evidence. The matrix is considered to be fragmented siltstone but extensive deformation of the incompetent fragments has resulted in their loss of identity as discrete fragments. In certain contact zones with stage 2 sandstone breccia it

commonly appears as if siltstone has been squeezed into fractures between sandstone blocks and sometimes shows a foliation parallel to the irregular fractures. Compositionally the clasts may be heterogeneous suggesting much transport and mixing (plate 2f). In places, stage 3 breccia composed exclusively of dolomite fragments in siltstone matrix and surrounded by brecciated siltstone (unit W) probably represents an original dolomite interbed in siltstone that has been brecciated with little translation of fragments relative to each other. In certain areas the stage 3 breccia has undergone subsequent shearing accompanied by super-imposition of a shear foliation on the siltstone matrix. In such a sheared breccia at 82+60W, 2+60S the fragments are smaller than in the adjacent unsheared breccia suggesting that shearing produced further comminution of the competent fragments as well as having foliated the matrix. Some stage three breccias contain thin (few millimeters) hematite stained albite veinlets while some interstitial secondary albite is locally present in the matrix. Secondary dolomitization is usually minor to nonexistent. The apparent unimportance of metasomatic alteration of the siltstone matrix breccias is likely due to their impermeability. As comminuted quartzo-feldspathic material becomes more important in the matrix there is an attendant increase in albitization and carbonatization making this unit transitional into unit S. On the other hand, where the stage 3 breccia contacts with sandstone, an intermediate brecciated sandstone zone is usually present. Where such a transition zone is absent the contact commonly is linear and marked by a narrow mylonite band indicative of a fault contact.

S. Dolomitized, albitized, stage 3 breccia with siltstone and comminuted matrix: These breccias are the most heterogeneous and locally variable breccias present in the map area. Fragment size ranges rapidly over short distances from 100 x 80 feet to finely comminuted rock. Fragments are predominantly of sandstones, dolomite, siltstone, shale, bostonite and rarely pink granite and granite gneiss (up to 10 feet across). The matrix is composed of deformed siltstone plus finely comminuted quartzo-feldspathic material that has undergone partial to extensive recrystallization, extensive to complete albitization and extensive dolomitization. This quartzo-feldspathic matrix is similar to that described for unit O. Weak hematization colors the albitic matrix red in hand sample. Large (up to 2 mm), well-zoned, euhedral dolomite crystals are abundant and preferentially replaced matrix. Solution of these dolomite crystals produces a "scoriaceous" weathering surface. This rock type occurs as large irregular "pipes" interconnected by breccia dykes. Variations are present within these "pipes" with respect to fragment composition but no pattern or symmetry of these variations has been noted. In general, fragment size decreases within a few feet of the edge of such a "pipe" and the margin is commonly lined by a banded microbreccia as described below. This unit is transitional to units O, Q, R, T and V.

T. Dolomitized, banded microbreccia: This rock type occurs as dykes (plate 3d) transecting sandstone and brecciated sandstone and as banded margins on irregular breccia pipes of unit S (plate 3g). In outcrop the lithology is finely banded, grey, and weathers with a "scoriaceous" texture due to solution of secondary dolomite crystals. The lithology is composed of 20 to 50% angular to subrounded frag-

ments of sandstone, siltstone, dolomite, bostonite, quartz and feldspar that rarely exceed 1 cm across. The matrix is finely comminuted rock material that has undergone extensive to complete albitization and recrystallization followed by extensive dolomitization that commonly exceeds 50% of the rock. Porphyroblasts (0.4 mm) of albite are common (up to 15% of matrix) in addition to the extremely fine matrix albite mosaic (0.004 mm to 0.015 mm). Complete recrystallization of quartz and albite to grain size up to 0.5 mm is also common. Banding is defined by variations in fragment's size, fragment composition, degree of recrystallization and degree of dolomitization (plate 6g). This banded lithology occurs in thicknesses from a few inches to a few feet only and where a banded dyke exceeds a few feet in width it becomes massive, although lithologically similar, in the center. The banding is continuous over distances up to several feet and parallels all the irregularities of the adjacent contact with sandstone or brecciated sandstone (plate 3; e, f). The essential difference between this lithology and the massive breccia dykes with comminuted matrix predominant (unit O) appears to lie in the fact that the latter rarely contain dolomite (and siltstone) fragments whereas abundant dolomite (and siltstone) fragments are typical of the former. The greater primary dolomite content of the banded microbreccia is likely responsible for its far more extensive dolomitization (recrystallized primary dolomite). Contacts with sandstone and brecciated sandstone are abrupt and intrusive while contacts with unit S may be sharp or gradational over several centimeters (plate 3h). Fragments of this lithology are found within irregular pipes of unit S and hence the

banded marginal phase (where present) of such pipes appears to be an early feature subjected to later brecciation.

V. Brecciated bostonite: This rock type is composed of angular, red-brown, dolomitized bostonite fragments with or without sandstone fragments in a red-brown, weakly to moderately dolomitized, microcrystalline albite matrix (plate 3c). The matrix generally constitutes less than 30% of the rock and is likely derived from recrystallization of finely comminuted bostonite. In places the matrix becomes more highly dolomitized and heterogeneous and grades into a bostonite rich stage 3 breccia of unit S. Brecciated bostonite is only found in close association with massive bostonite intrusions.

W. Brecciated and/or sheared siltstone: The brecciated siltstone is usually composed of angular, dark grey siltstone fragments in a deformed dark grey siltstone matrix. Recognition of the brecciated nature of this siltstone is often difficult and hence contacts with unbrecciated siltstone are usually approximate. In places small amounts of all lithologies included in unit F are involved. Clasts range to at least several feet across. In places the siltstone and brecciated siltstone have been extensively sheared with imposition of a shear foliation. In such sheared siltstone it is impossible to tell whether the original rock was brecciated or not and in places it is difficult to distinguish from sheared stage 3 breccia. As a result this unit includes both sheared siltstone breccia and sheared siltstone. The large body of siltstone around 74+00W is thought to be mostly sheared with large boudin-like clasts of dolomite and rarely sandstone but poor exposure prohibits a more detailed analysis.

X. __Brecciated dolomite__: This rock type is analagous to stage 2 sandstone breccia except the clasts are almost exclusively dolomite and the matrix is coarse crystalline dolomite plus some siltstone.

Y. __Brecciated fine red micaceous sandstone__: This unit is sandstone of unit J that has been brecciated to a degree equivalent to stage 1 and 2 brecciation.

Z. __Quartz-mylonite veins__: These veins are composed of coarse crystalline white quartz which is commonly drusy and locally contains a large proportion of mylonite fragments (up to 60%). Mylonite fragments are most abundant where such a vein cuts sandstone and less abundant where it cuts sheared siltstone. This suggests that the veins represent faults in which post lithification shearing induced mylonitization of the competent sandstone but resulted only in shearing of the incompetent siltstone. Post-movement quartz veining brecciated the mylonite and siltstone with accompanying chloritization of siltstone fragments. The quartz is known to contain up to 0.6 oz gold /ton and minor chalcopyrite, pyrite and bornite. Limonite staining is locally prominent both in the veining and in sandstone immediately adjacent.

Ø. __Sandstone-syenite breccia__: In this unit the sandstone has been brecciated to the degree of a stage 1 breccia and locally to stage 2 but the matrix and fracture filling is altered and partially comminuted albite syenite. This unit was found only at 6+00E, 12+50N and the syenite matrix is identical to syenite which outcrops in the large dyke immediately north. The mafics in the syenite have been altered to a soft yellow-green mass. Thin sections show that some of the sandstone and syenite matrix has been comminuted but inclusion of sandstone fragments in coarse syenite definitely demonstrates the younger age of the large dyke. The partial

comminution of syenite and sandstone in this unit appears to be the result of nearby diatreme activity and suggests pre-diatreme age for the syenite dyke.

Base Line 1 Lithologic Descriptions

Basement (Slave Structural Province)

A. Granite and granite gneiss: Pink with sparse biotite and muscovite, locally pegmatitic.

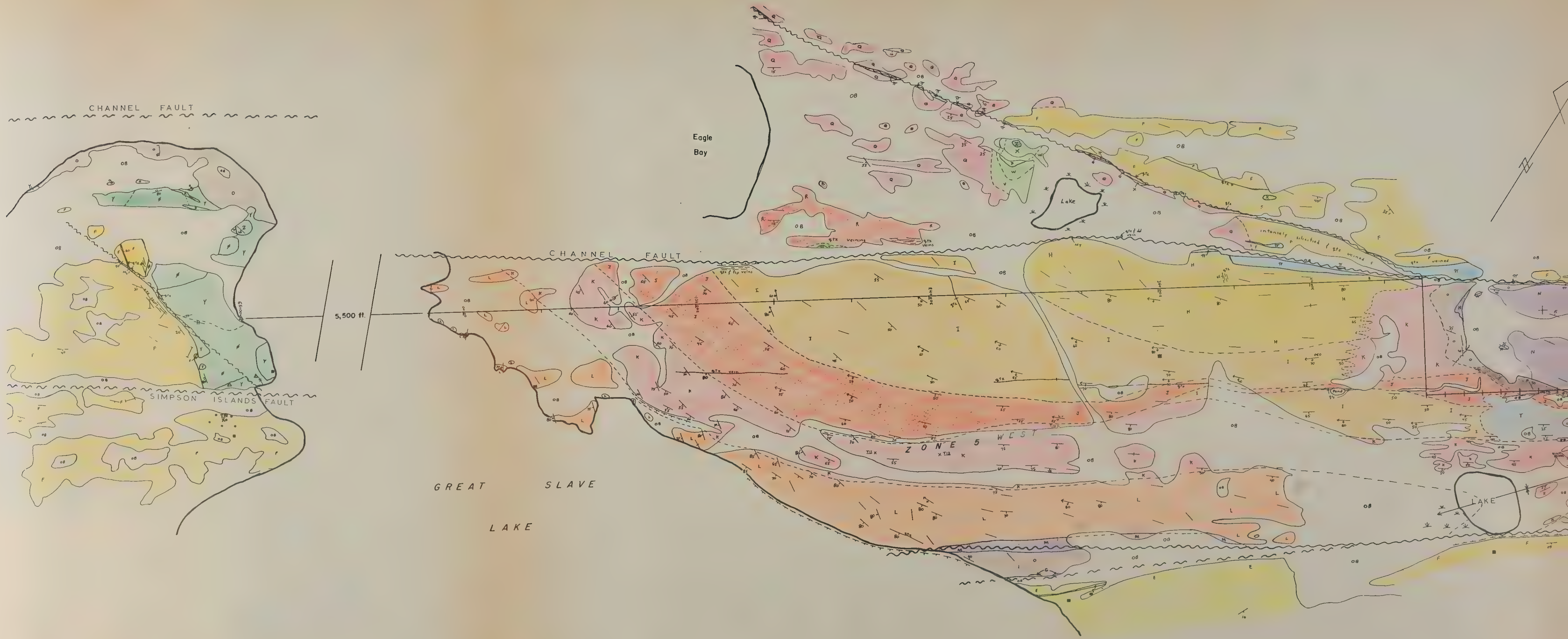
B. Diabase: Black, slightly dolomitized with chilled margins. The diabase dyke appearing in the basement granites east of Romeo Lake belongs to a northeast trending swarm believed to predate the Hornby Channel Formation.

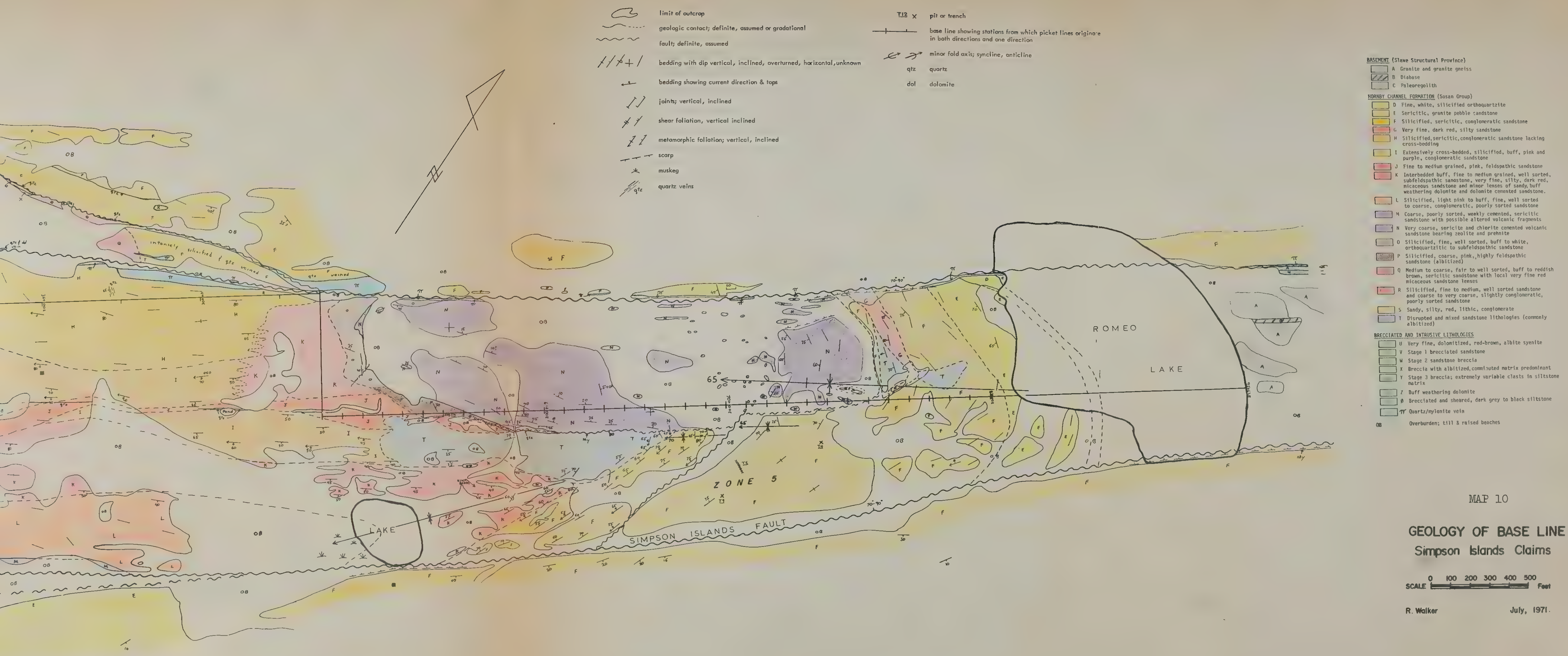
C. Paleoregolith: Highly altered, green granite. The mafics and feldspar are almost completely altered to sericite resulting in a green color. This lithology crops out only on the west corner of Romeo Lake and due to proximity to the Channel Fault and its associated quartz vein, the paleoregolith is veined by abundant irregular quartz stringers (up to 50%). Some limonite staining from oxidation of pyrite is evident. This pyrite is believed to have been introduced from the adjacent fault at the time of quartz vein formation.

Hornby Channel Formation (Sosan Group)

D. Fine, white, silicified orthoquartzite: Fine to very fine well sorted, highly silicified, white to very pale pink, over 95% quartz. Extensively veined by quartz stringers (up to 50%) originating from the adjacent fault and quartz vein.

E. Sericitic, granite pebble sandstone: Medium to very coarse, slightly conglomeratic to conglomeratic, fair to poor sorting, subfeldspathic to feldspathic, buff to brown. Abundant brownish weathering sericite


CHANNEL FAULT
SIMPSON ISLANDS FAULT
5,500 ft.
Eagle Bay
CHANNEL FAULT
Lake
qtz veining
intensely silicified & qtz veined
ZONE 5 WEST
GREAT SLAVE LAKE
LAKE
Pond
qtz vein

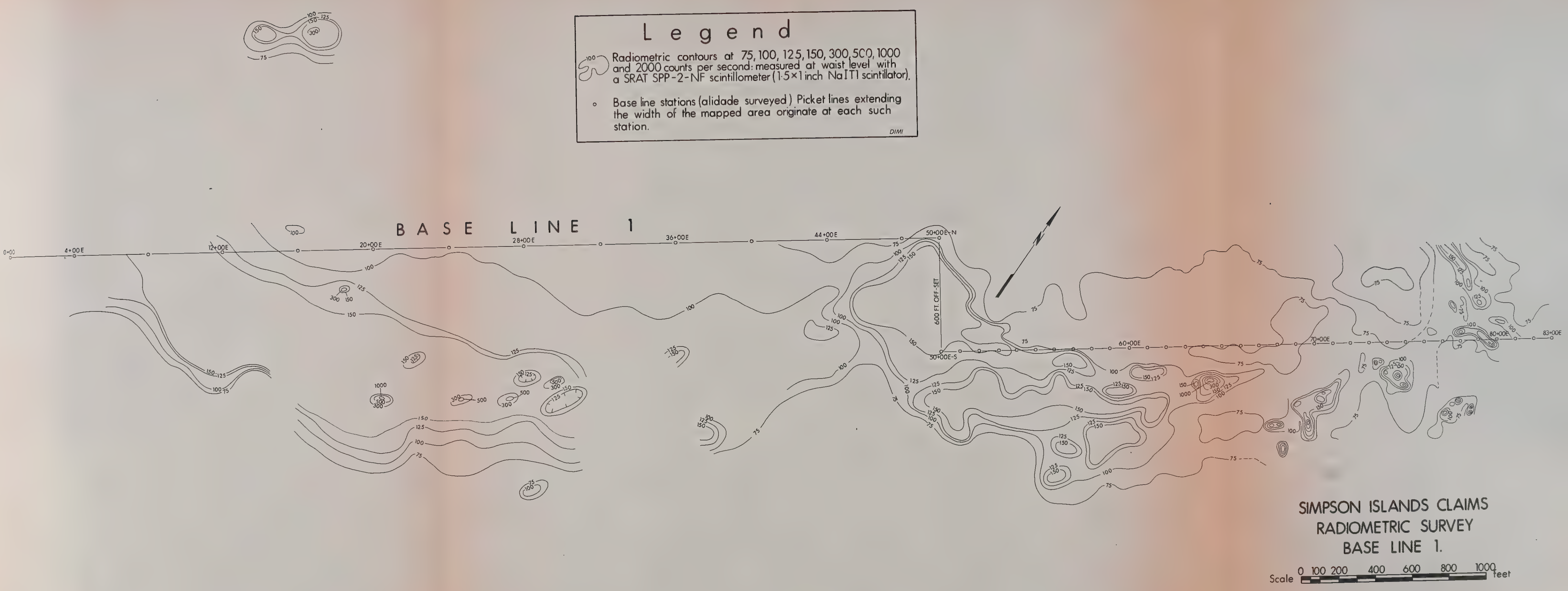

limit of outcrop
geologic contact; definite, assumed or gradational
fault; definite, assumed
bedding with dip vertical, inclined, overturned, horizontal, unknown
bedding showing current direction & tops
joints; vertical, inclined
shear foliation, vertical inclined
metamorphic foliation; vertical, inclined
scarp
muskeg
qtz
quartz veins
T12 X pit or trench
base line showing stations from which picket lines originate in both directions and one direction
minor fold axis; syncline, anticline
qtz quartz
dol dolomite
BASEMENT (Slave Structural Province)
A Granite and granite gneiss
B Diabase
C Paleoregolith
HORNBY CHANNEL FORMATION (Sosan Group)
D Fine, white, silicified orthoquartzite
E Sericitic, granite pebble sandstone
F Silicified, sericitic, conglomeratic sandstone
G Very fine, dark red, silty sandstone
H Silicified, sericitic, conglomeratic sandstone lacking cross-bedding
I Extensively cross-bedded, silicified, buff, pink and purple, conglomeratic sandstone
J Fine to medium grained, pink, feldspathic sandstone
K Interbedded buff, fine to medium grained, well sorted, subfeldspathic sandstone, very fine, silty, dark red, micaceous sandstone and minor lenses of sandy, buff weathering dolomite and dolomite cemented sandstone.
L Silicified, light pink to buff, fine, well sorted to coarse, conglomeratic, poorly sorted sandstone
M Coarse, poorly sorted, weakly cemented, sericitic sandstone with possible altered volcanic fragments
N Very coarse, sericite and chlorite cemented volcanic sandstone bearing zeolite and prehnite
O Silicified, fine, well sorted, buff to white, orthoquartzitic to subfeldspathic sandstone
P Silicified, coarse, pink, highly feldspathic sandstone (albitized)
Q Medium to coarse, fair to well sorted, buff to reddish brown, sericitic sandstone with local very fine red micaceous sandstone lenses
R Silicified, fine to medium, well sorted sandstone and coarse to very coarse, slightly conglomeratic, poorly sorted sandstone
S Sandy, silty, red, lithic, conglomerate
T Disrupted and mixed sandstone lithologies (commonly albitized)
BRECCIATED AND INTRUSIVE LITHOLOGIES
U Very fine, dolomitized, red-brown, albite syenite
V Stage 1 brecciated sandstone
W Stage 2 sandstone breccia
X Breccia with albitized, comminuted matrix predominant
Y Stage 3 breccia; extremely variable clasts in siltstone matrix
Z Buff weathering dolomite
Ø Brecciated and sheared, dark grey to black siltstone
π Quartz/mylonite vein
OB Overburden; till & raised beaches
ROMEO
LAKE
ZONE 5
LAKE
SIMPSON ISLANDS FAULT
intensely silicified
qtz veined
veined
Pond
65
SCALE
0 100 200 300 400 500
Feet

MAP 10

GEOLOGY OF BASE LINE 1

Simpson Islands Claims

R. Walker July, 1971.



Legend

100 Radiometric contours at 75, 100, 125, 150, 300, 500, 1000 and 2000 counts per second: measured at waist level with a SRAT SPP-2-NF scintillometer (1·5×1 inch NaITl scintillator).

○ Base line stations (alidade surveyed) Picket lines extending the width of the mapped area originate at each such station.

DIMI

SIMPSON ISLANDS CLAIMS
RADIOMETRIC SURVEY
BASE LINE 1.

cement gives a green color to the rock when fresh. Phenoclasts are dominantly of quartz, quartzite and sandstone but granitic granules and pebbles are abundant. Less common clasts are of red and green siltstone, mylonite, and jasper. Generally the gravel fraction is dispersed in medium to coarse sand that is reasonably well sorted. Locally the rock is hematite stained.

F. Silicified, sericitic, conglomeratic sandstone: This map unit is variable over short distances with respect to cement, grain size and feldspar content. The sandstone ranges from medium to very coarse and is generally conglomeratic or slightly conglomeratic (up to pebbles, but with granules predominant). It is generally subfeldspathic but locally orthoquartzitic or feldspathic. It is generally white to buff, strongly cemented and well silicified but large lenses and areas with more sericitic cement (up to 25%) and brownish color are present. Grain size and hematite sand laminae define bedding and cross-bedding. Numerous scour surfaces are present as well as rare graded beds with basal scours. Phenoclasts are of quartz, quartzite and rarely chert. This rock unit has been found to contain numerous lenses of pale green microcrystalline sericite which are recessive and don't outcrop. The lenses vary from thumbnail size to ten feet thick and those uncovered by trenching are tectonically squeezed, sheared and seldom parallel bedding. Megascopically the lenses are pale green mudstone but microscopically they consist of recrystallized microcrystalline sericite free of quartz and with dusting of what may be iron oxide (goethite?). A relict spherulitic texture (about 10 - 20% spherules)in some sections suggests an origin by alteration of an original glassy tuff (plate 4h).

G. Very fine, dark red, silty sandstone: Well sorted, subangular to rounded, strongly to weakly cemented, strongly hematized. This lithology is often micaceous containing up to 15% detrital muscovite flakes that are sorted but larger than the quartzo-feldspathic fraction. Cementing is by silica contact cement, up to 25% recrystallized sericite and 10% hematite. This lithology is massive or thinly bedded to laminated with bedding becoming more evident with an increase in silt and muscovite content. The muscovite flakes show a bed-parallel preferred orientation. This rock type has an unusually high background radioactivity as indicated on the base line 1 radiometric map (map 11).

H. Silicified, sericitic, conglomeratic sandstone lacking cross-bedding: Similar to unit F except that cross-bedding is generally rare.

I. Extensively cross-bedded, silicified, buff, pink and purple, conglomeratic sandstone: Medium to granule sized, moderately sorted, subfeldspathic to feldspathic. The granule sized fraction is oligomictic being composed of quartz and quartzite. Abundant festoon cross-beds and hematite laminations typify this unit. The lower contact is a gradual transition with unit H while the upper contact is gradational by interbedding with unit J on a scale of about 1 foot thick interbeds.

J. Fine to medium grained, pink feldspathic sandstone: Well sorted and silicified. At least some of this lithology is partially albitized (see chapter VI) but the extent of this alteration is unknown. In places this unit contains up to 20% buff, medium to coarse, well sorted, sericitic sandstone and minor, fine, dark red, micaceous sandstone (especially near the top of the unit). The contact with the overlying unit K is gradational by interbedding over a few tens of feet.

K. Interbedded, buff, fine to medium grained, well sorted, subfeldspathic sandstone, very fine, silty, dark red, micaceous sandstone and minor lenses of sandy, buff weathering dolomite and dolomite cemented sandstone: The rocks included in this unit are described as follows:

i) Buff weathering, fine to medium, well sorted, subfeldspathic sandstone: This lithology, which comprises most of the unit, is pale green or pale pink when fresh due to sericite cement and feldspar respectively.

ii) Very fine, silty, dark red, micaceous sandstone: This rock varies from fine sandstone to silstone. The same as unit G.

iii) Sandy, buff weathering dolomite to dolomite cemented sandstone: This rock is composed of up to several tens of percent very fine to coarse quartz sand in compact dolomite with a few percent coarsely crystalline secondary dolomite. In many places the rock is somewhat hematized and weathers rusty brown whereas it is buff to purplish red when fresh. This rock type occurs as lenses generally less than 3 feet thick in rock type ii above.

This map unit has an unusually high radioactive background and is coincident with several anomalies defined on the radiometric map of base line 1 (map 12). Contacts are gradational and cross-beds and hematite laminae are absent.

L. Silicified, light pink to buff, fine and well sorted to coarse, conglomeratic and poorly sorted sandstone: This rock unit is variable along strike. At the west end of base line 1 it is buff, medium grained and well sorted to coarse and moderately sorted. Around 8+00E the unit becomes very coarse, conglomeratic and poorly sorted with prominent

cross-bedding. Around 28+00E the unit is fine to medium, well sorted and pale pink. Here it begins to resemble unit J. At the eastern end of its exposure the unit again becomes coarser and more poorly sorted. Strike of bedding in this unit frequently appears to deviate from the lower contact (which is gradationl). This is most likely due to large cross beds which commonly cannot be recognized through lichen cover. Hematite laminations are sparse in this unit.

M. Coarse, poorly sorted, weakly cemented, sericitic sandstone with possible altered volcanic fragments: This sandstone weathers buff to brown and presents a rubbly outcrop due to the easily weathered sericite cement (up to 35%). Locally secondary carbonate cement is important. This rock contains small blebs (up to a few millimeters) of pale yellow-green sericite that are probably altered remnants of original volcanic clasts. This is indicated by their similarity in appearance to sericitized volcanic clasts in the sandstone of unit N intersected by drill holes. Both contacts are abrupt and hematite laminations are absent.

N. Very coarse, sericite-and chlorite-cemented volcanic sandstone bearing pumpellyite and prehnite: Poorly sorted, coarse to very coarse, slightly conglomeratic, angular to rounded, feldspathic sandstone which is generally dark green when fresh but weathers red to reddish brown. Near the edges of the unit the rock commonly lacks chlorite and as a result is buff to greenish. This rock contains up to 50% altered volcanic rock fragments as well as minor white sandstone, red siltstone, granite and chert fragments. The volcanic fragments are angular and are generally granule size although pebbles and rare cobbles exist. The volcanic fragments are altered to the following minerals: chlorite, sericite, prehnite, pumpellyite, albite, opaques

and carbonate. The carbonate and chlorite are paragenetically last and second last respectively. The volcanic clasts typically show spherulitic replacement by chlorite, prehnite, pumpellyite and albite (plate 4f) while carbonate often pseudomorphs spherules. Many clasts appear deformed by compaction. Albite, chlorite, prehnite and extensive dusty opaques occur in the matrix of the sandstone as well as clasts. The mineral assemblage indicates metamorphism of the pumpellyite-prehnite-quartz facies. Within several feet of the contact of this unit the rock lacks chlorite, and sericite, often with a spherulitic texture (plate 4g), becomes the dominant alteration product of volcanic material. The west end of the rock unit appears to show a depositional contact with unit O that is gradational over several inches. The contact at the east end of the unit may also be depositional and similar. The volcanic sandstone in which only sericite alteration is present is similar to unit M and these two units are probably time stratigraphically equivalent. This sandstone is a mixture of very immature volcanic debris and submature quartzo-feldspathic sand. This lithology lacks cross-beds and hematite laminations although hematite-quartz veinlets are common.

O. Silicified, fine, well-sorted, buff to white, orthoquartzitic to subfeldspathic sandstone: This sandstone is massive and lacks hematite laminations.

P. Silicified, coarse, pink, highly feldspathic sandstone: This unit is massive and contains abundant quartz veins. It is extensively albitized (up to 40%) and the weak hematization of the replacive and interstitial albite produces the pink color.

Q. Medium to coarse, fair to well sorted, buff to reddish brown, sericitic sandstone with local, very fine, red, micaceous sandstone lenses: This lithology weathers buff to reddish brown but would likely be green when fresh due to the sericite cement. The included lenses of very fine red micaceous sandstone are similar to unit G.

R. Silicified, fine to medium, well sorted sandstone and coarse to very coarse, slightly conglomeratic, poorly sorted sandstone: This unit is variable over short distances from fine to medium grained and well sorted sandstone to coarse to very coarse, slightly conglomeratic and poorly sorted sandstone. Both sandstone types are white to buff and subfeldspathic. The finer fraction generally predominates.

S. Sandy, silty, red, lithic conglomerate: The framework constitutes 40 to 70% and is composed of granules, pebbles and cobbles of quartzite, quartz, sandstone, siltstone, granitic rocks, chert (?) and mylonite (?). The matrix is silty to coarse, poorly sorted and is dark red due to hematization. The rock has a disrupted framework and is poorly sorted. Large clasts are well rounded.

T. Disrupted and mixed sandstone lithologies: This unit appears to have undergone extensive soft sediment deformation, possibly as a result of slumping. Sandstone lithologies are disrupted and mixed in an irregular fashion on a scale that varies from a few inches to a few tens of feet (plate 1d). The rock types involved appear to be from units F, G, H, I and J. Plate 4d shows the bimodal sorting and angularity of some of the sandstone indicative of mixing of two component sands. Albitization of detrital feldspar is at least locally important and is probably extensive. In the large disrupted body around 61+00E and 2+00S there is a gradational increase in lithology J from east to west where it comprises 90% of the unit.

Lithology J first appears as interbeds up to a few feet thick on the east. This interbedding of lithology J with lighology F is similar to the interbedding of lithologies J and I farther west. This, combined with the prominent cross-bedding, suggests stratigraphic equivalence between unit I and the upper part of unit F.

Brecciated and Intrusive Lithologies

U. Dolomitized, red-brown, albite syenite: This is a narrow, medium grained continuation of the large syenite dyke mapped on base line 2. It is composed of hematite stained, subhedral albite which is locally antiperthitic and which has been largely (60%) replaced by secondary dolomite. The mafics are completely destroyed but were probably pyroxene, hornblende and biotite. The texture is medium grained hypidiomorphic granular.

V. Stage 1 brecciated sandstone: See description for unit P, base line 2.

W. Stage 2 sandstone breccia: See description for unit Q, base line 2.

X. Breccia with albitized, comminuted matrix predominant: See description for unit O, base line 2.

Y. Stage 3 breccia; extremely variable clasts in siltstone matrix: See description for unit R, base line 2.

Z. Buff weathering dolomite: Compact, varicolored, laminated to thin bedded dolomite. Siliceous laminae and thin veinlets are common while bedding is often wavy and occasionally ripple marked. Locally the compact dolomite has been partially recrystallized to coarse crystalline, white, secondary dolomite. This dolomite is abundant in stage 3 breccias and in one location at the west end of the base line fragments were definitely stromatolitic of the laterally linked hemispheroid type. (plate 1; e,f)

Ø. Brecciated and sheared, dark grey to black siltstone: Almost all of the siltstone exposed on base line 1 (mostly at the west end) has been sheared to some extent as is evidenced by a shear foliation. Where the siltstone is not sheared it usually appears brecciated with small angular and deformed clasts of siltstone in a siltstone matrix. This internally brecciated siltstone grades into stage 3 breccia. Locally the brecciated or sheared siltstone contains scattered rhombs, of secondary dolomite. Before brecciation the dolomite of unit Z was interbedded in thin bedded to laminated dark grey siltstone. Such interbeds are now often represented as zones of stage 3 breccia in which most or all fragments are dolomite.

π Quartz/mylonite vein: These veins are predominantly of white, coarse crystalline quartz which is locally drusy and commonly contains minor disseminated pyrite and chalcopyrite which have produced local limonite staining. In places the veins appear to have been subsequently mylonitized. In other places angular mylonite clasts appear in quartz suggesting pre-quartz mylonitization. Locally thin mylonite lenses appear without crystalline quartz. Quartz veins without mylonite are usually thin and are labelled separately on the map.

The thin but prominent quartz vein that subparallels the base line at about 4+00S was not seen to contain mylonite but it may be the westward extension of the fault that forms the south contact of unit N.

The lack of mylonite and appreciable stratigraphic offset implies a minimum of movement west of 50+00E.

Quartz veins commonly grade through a quartz vein stockwork into the surrounding sandstone and arbitrarily such a system containing more than 50% quartz veining was mapped as a quartz vein.

The most prominent and largest veins are those coincident with major northeast faults. In addition to these there are abundant, small, discontinuous, steeply dipping quartz veins striking east-southeast.

Stratigraphic Correlations and General Comments on the Base Lines 1 & 2 Geology Maps

The lithologic descriptions and map unit names used for the two base line maps were set up independently of each other. This was necessitated by the large number of map units and the many stratigraphic uncertainties encountered. Those rock units thought to be equivalent between the two base line geology maps (maps 8 & 10) are listed in table 3.

Rock Unit of Base Line 2	Equivalent Unit of Base Line 1
A	A
B	C
C	D
D	E
E	F
G	Z
M	U
O	X
P	V
Q	W
R	Y
W	Ø
Z	π

Table 3: Equivalent map units from base lines 1 and 2

This table, in the case of undisturbed sediments, implies lithostratigraphic equivalence. In the case of intrusive and brecciated rock types lithological similarity and petrogenetic equivalence is assumed. In either case the lithologic descriptions are usually not identical.

The areas represented by the two base line geology maps have undergone a long and involved geologic history in Aphebian time that included subareal weathering, sedimentation, metamorphism, magmatism, diatreme activity, a protracted period of repeated faulting, and metasomatism.

The area of base line 2 (map 8) is predominantly underlain by a thick sandstone succession which represents the lowermost several hundred feet of the Hornby Channel Formation. These sandstones dip toward Vestor Channel south-southeast from near vertical to near horizontal. Bedding dips are moderate to shallow in the central and northeast portions of the map area but gradually steepen towards the southwest. This prism of sandstone has been intruded by several stocks and dyke-like bodies of bostonite which in all probability are interconnected within several hundred feet of the present erosion surface. Subsequent to bostonite emplacement, the area, as well as portions of base line 1 and elsewhere along the Simpson Islands fault system, was cut by irregular diatreme breccia "pipes" and dykes. The intrusive history is discussed in chapter V. Figures 7, 8 and 9 are geologic cross sections taken normal to base line 2 and represent the range of features encountered on this base line. The sections transect four radioactive zones and data from the diamond drilling of the radioactive zones is incorporated although only those holes lying in the planes of the sections are represented diagramatically.

The Hornby Channel Formation underlying the area mapped along base line 1 (map 10) is sedimentologically much more complex than that of base line 2. Sandstones on base line 1 were grouped on the basis of lithologic similarity and as a result certain contrasting lithologies were mapped separately although they appear to be stratigraphically equivalent whereas other separated outcrops ascribed to the same map unit (such as unit F) may belong to distinct stratigraphic levels.

The mapping of the base line 1 area was primarily concerned with the geology in the wedge between the Channel fault and the Simpson Islands fault. Within the northeast apex of this fault block granitic basement is exposed surrounded by and in fault contact with Hornby Channel Formation

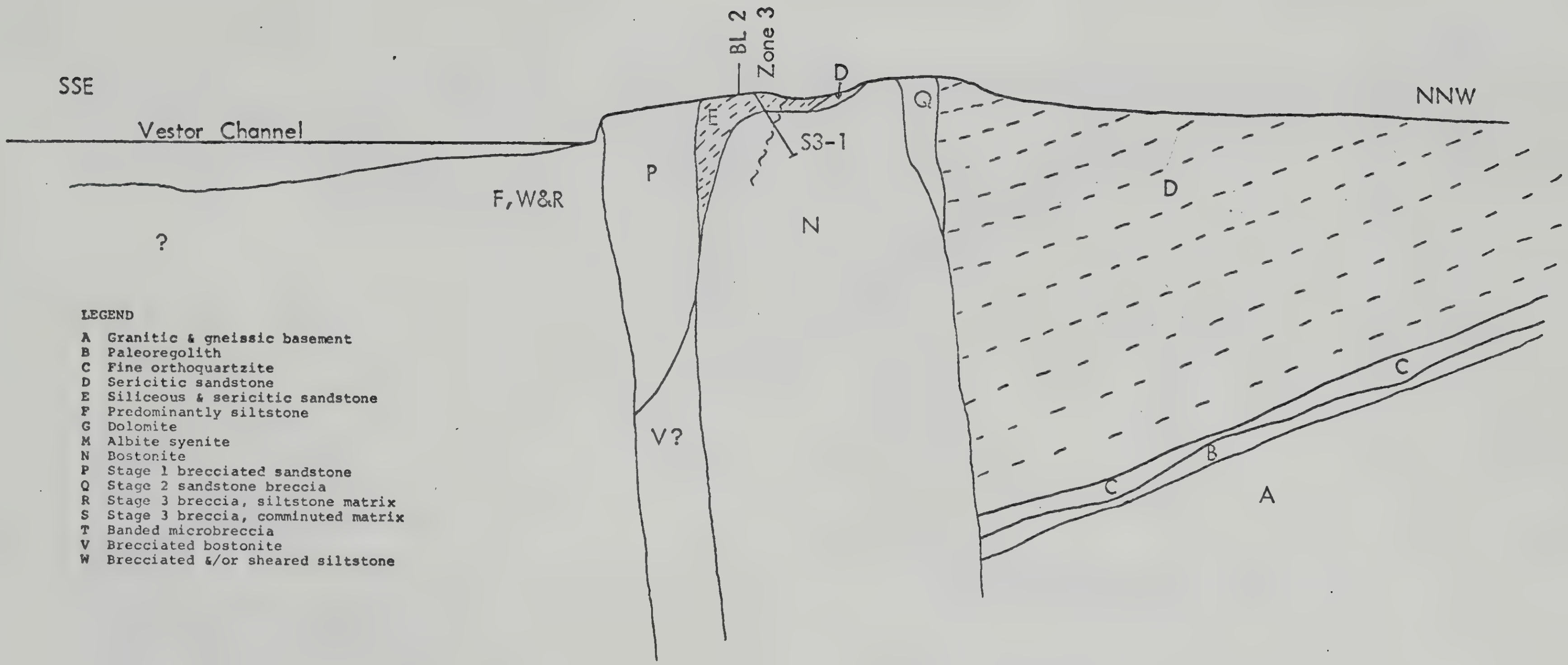
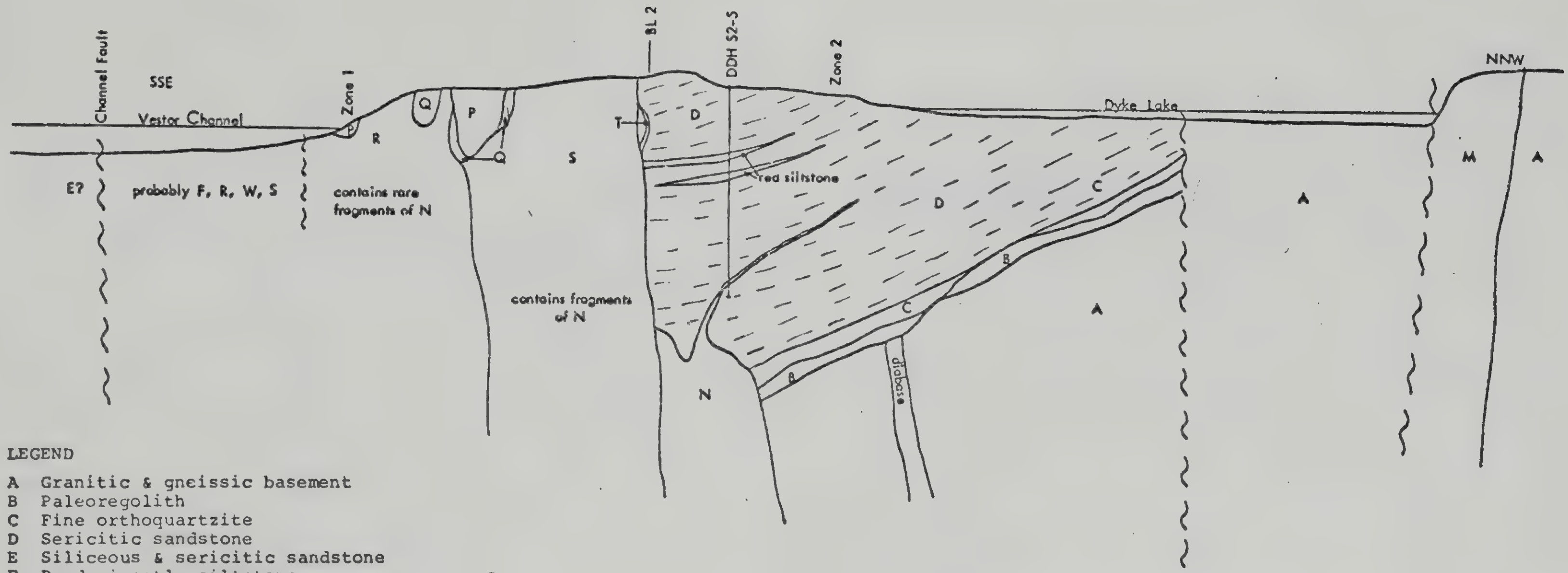

BL 2
Zone 3
D
SSE
NNW
Vestor Channel
Q
E
S3-1
P
D
F, W&R
N
?
V?
C
B
A
C
LEGEND
A Granitic & gneissic basement
B Paleoregolith
C Fine orthoquartzite
D Sericitic sandstone
E Siliceous & sericitic sandstone
F Predominantly siltstone
G Dolomite
M Albite syenite
N Bostonite
P Stage 1 brecciated sandstone
Q Stage 2 sandstone breccia
R Stage 3 breccia, siltstone matrix
S Stage 3 breccia, comminuted matrix
T Banded microbreccia
V Brecciated bostonite
W Brecciated &/or sheared siltstone

Figure 7

Schematic Cross Section Normal to Base Line 2 at 3+45 W
Scale: 1 inch =170 feet; no vertical exaggeration
See Base Line 2 Geology Map for legend



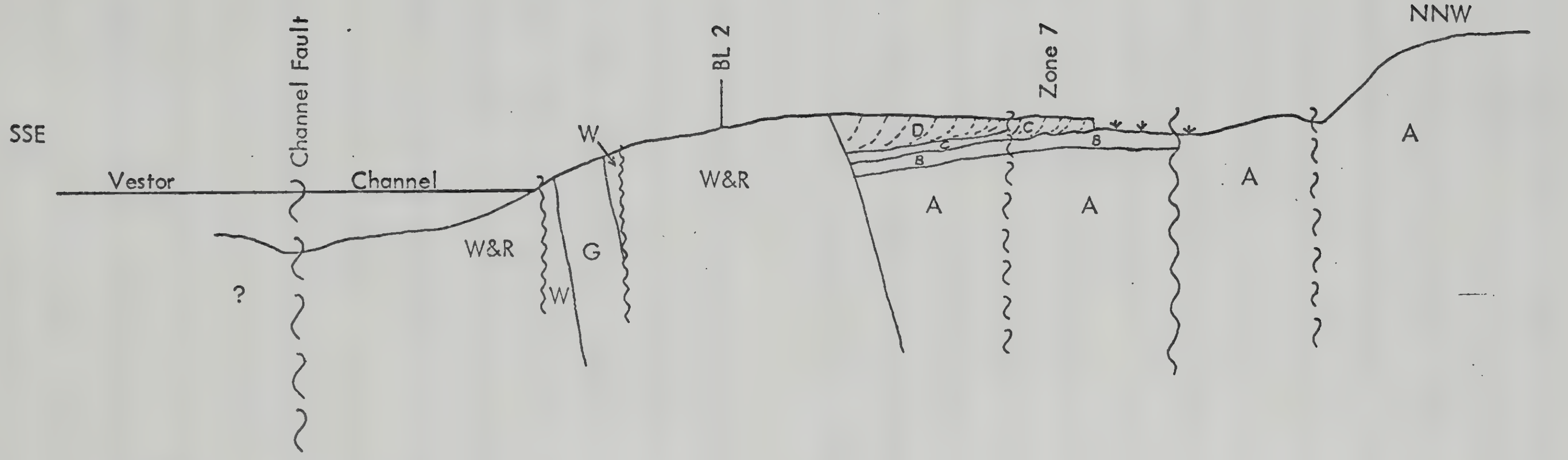
LEGEND

- A Granitic & gneissic basement
- B Paleoregolith
- C Fine orthoquartzite
- D Sericitic sandstone
- E Siliceous & sericitic sandstone
- F Predominantly siltstone
- G Dolomite
- M Albite syenite
- N Bostonite
- P Stage 1 brecciated sandstone
- Q Stage 2 sandstone breccia
- R Stage 3 breccia, siltstone matrix
- S Stage 3 breccia, comminuted matrix
- T Banded microbreccia
- V Brecciated bostonite
- W Brecciated &/or sheared siltstone

FIGURE 8

Schematic Cross Section Normal to Base Line 2 at 10+75 W
See Base Line 2 Geology Map for Legend

Scale - both Vertical & Horizontal
0 feet 500
R. Walker October, 1971



LEGEND

A	Granitic & gneissic basement
B	Paleoregolith
C	Fine orthoquartzite
D	Sericitic sandstone
E	Siliceous & sericitic sandstone
F	Predominantly siltstone
G	Dolomite
M	Albite syenite
N	Bostonite
P	Stage 1 brecciated sandstone
Q	Stage 2 sandstone breccia
R	Stage 3 breccia, siltstone matrix
S	Stage 3 breccia, comminuted matrix
T	Banded microbreccia
V	Brecciated bostonite
W	Brecciated &/or sheared siltstone

Figure 9

Schematic Cross Section Normal to Base Line 2 at 73+50 W
Scale: 1 inch = 170 feet; no vertical exaggeration
See Base Line 2 Geology Map for legend

sandstone (map 15). Romeo Lake overlies the basal unconformity, a small section of which is exposed at the northwest corner of the lake. Towards the southwest of the fault wedge generally higher stratigraphic levels of the Hornby Channel Formation are exposed. The fault wedge seems to have undergone rotational displacement with the northeastern apex having been upthrown whereas towards the southwest, higher stratigraphic levels within the fault wedge are juxtaposed with probably lower stratigraphic levels across the Simpson Islands fault. A net scissors movement on this fault is implied although this likely took place through a complex history of repeated movement. North of the fault wedge a major splay from the Channel fault complicates the structure making interpretations of stratigraphic level uncertain except to say that sandstones exposed north of the Channel fault are thought to be within the lower 1000 feet of the Hornby Channel Formation.

The Hornby Channel Formation sandstones within the base line 1 fault wedge have been folded about steeply west-southwest plunging fold axes to produce steep to very steep dips in the northeastern part of the wedge. Towards the southwest, structural deformation becomes less severe and a moderately south to south-southwest dipping stratigraphic succession is present. As previously discussed (chapter 11) folding is thought to have been related to movement on the bounding faults and probably took place before complete lithification of the sediments. It is highly unlikely that the underlying Archean crystalline rocks were involved in the folds observed in the overlying sediments. The unconformity was likely a horizon of décollement and probably dips at a low angle southwest under the sandstone. The structural cross section normal to base line 1 presented in figure 12 suggests a depth to basement at 60 + 00E of 1400 feet which indicates the basal unconformity probably dips at 30° southwest within the fault wedge.

The sandstones of base line 1 compose a rather complex and locally highly variable stratigraphic section comprising approximately the lower 1700 feet of the Hornby Channel Formation. The geology within the area is straight-forward except for the outcrop of volcanic sandstone (unit N) and the area immediately surrounding this outcrop. This area presents a severe structural and stratigraphic problem which has not been adequately resolved. Factors thought to be important in the geological interpretation of this area are listed below:

a) Unit N (volcanic sandstone) appears to have been folded into a basin-like configuration with gentle dips towards the southwest and steep dips to the northeast.

b) Both the northwest and southeast flanks of unit N are bounded by faults.

c) Unit M is thought to be equivalent to unit N and as such may define the time stratigraphic level of the two units.

d) Units N and M are local in extent and do not occur elsewhere in the thesis area.

e) Unit N appears to overlie a lower stratigraphic level at its northeast end compared to its southwest end.

f) Severe sedimentary deformation, probably due to slumping, is evidenced by unit T which occurs in two places, both of which are marginal to unit N and which themselves appear to occupy different stratigraphic levels.

g) Unit F west of zone 5 appears similar to unit H while the transition zone between units H and I is similar to the transition zone between units F and T west of zone 5.

h) Southwest of zone 5, unit K directly overlies unit F whereas farther west units I and J underly unit K and overlie unit H

which is the possible equivalent of the upper part of unit F. If this apparent ambiguity were to be explained by lateral facies variation the area of pinching out of units I and J is occupied by a large probable "slump" structure (unit T) which involves lithologies similar to I and J as well as others. Immediately to the west of this "slump" structure units I and J definitely undergo internal lateral variation.

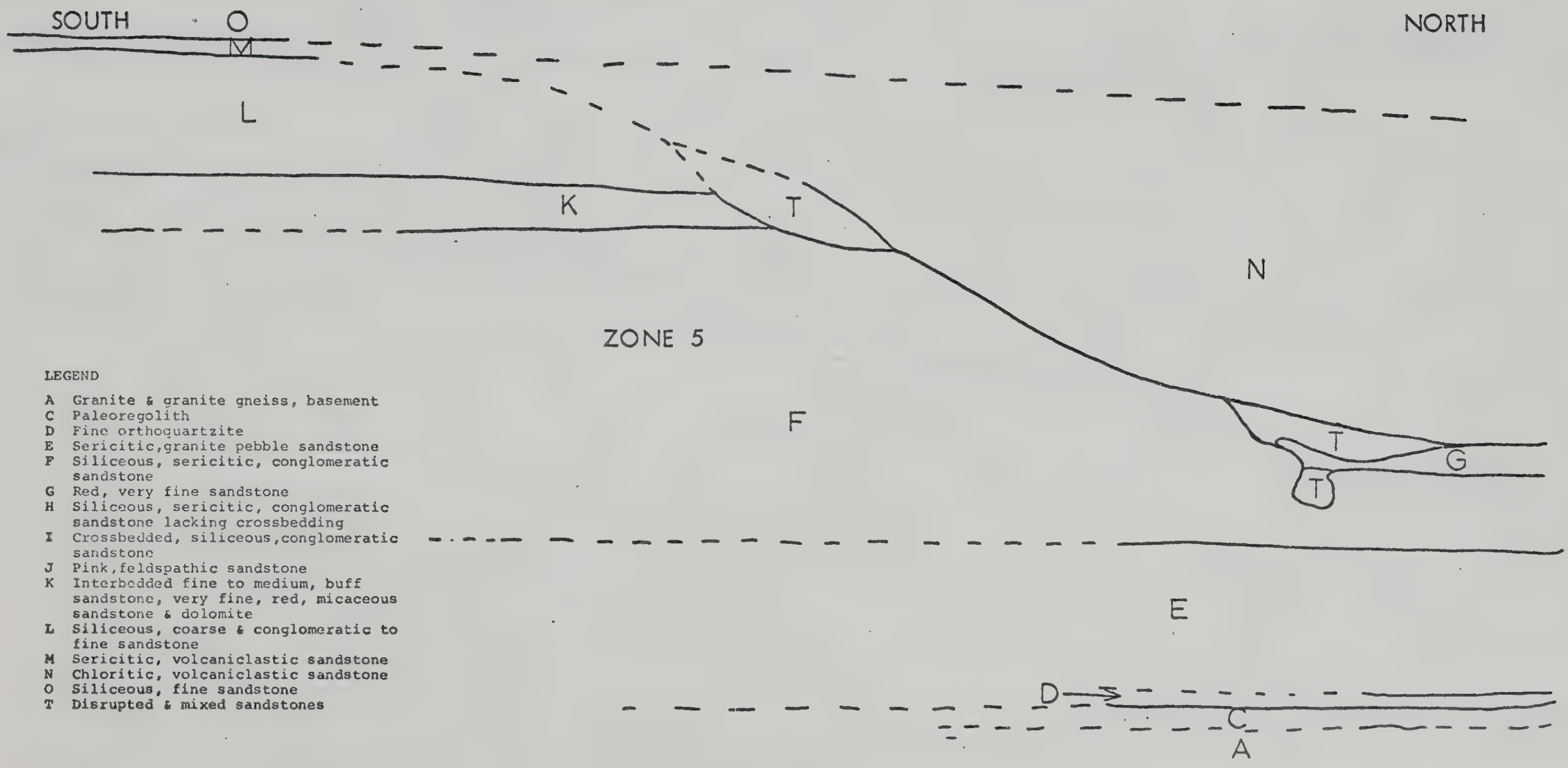
i) Units K and O immediately west of unit N present a particularly difficult problem both structurally and stratigraphically. The problem is aggravated by ill defined contacts and the map in this area should be considered somewhat generalized. Unit K here is not thought to be the stratigraphic equivalent of unit K elsewhere and its presence may be due to rapid lateral facies variation. Unit O in this area is also probably not stratigraphically equivalent to unit O elsewhere.

Given the above observations one could speculate that the distribution of the volcanic sandstone, unit N, and surrounding rock types is due to rapid lateral facies variation, sedimentary slumping, partial discordance of unit N as a channel fill feature and subsequent folding and faulting. It is worth nothing that the associated sedimentary processes invoked are compatible; i.e. they might be expected to occur together.

Figures 10 and 11 present schematic, palinspastic, stratigraphic reconstructions from base line 1 made on the basis of relations seen north and west of zone 5 in the case of figure 10 and north of zone 5 and southwest of unit N in the case of figure 11. Thus the stratigraphic section at the right hand edge of both diagrams is the same. In figure 10 if one were to view progressively farther away at right angles to the plane of the section, units I and J would appear between units K

Figure 10

Schematic Palinspastic Stratigraphic Reconstruction
Eastern Portion of Base Line 1
Horizontal scale: 1inch =170 feet (approx.)
Vertical scale: 1inch =320feet (approx.)
Vertical exaggeration = 1.9X
See Base Line 1 Geology Map legend for rock units



LEGEND

A	Granite & granite gneiss, basement
C	Paleoregolith
D	Fine orthoquartzite
E	Sericitic,granite pebble sandstone
F	Siliceous, sericitic, conglomeratic sandstone
G	Red, very fine sandstone
H	Siliceous, sericitic, conglomeratic sandstone lacking crossbedding
I	Crossbedded, siliceous,conglomeratic sandstone
J	Pink,feldspathic sandstone
K	Interbedded fine to medium, buff sandstone, very fine, red, micaceous sandstone & dolomite
L	Siliceous, coarse & conglomeratic to fine sandstone
M	Sericitic, volcaniclastic sandstone
N	Chloritic, volcaniclastic sandstone
O	Siliceous, fine sandstone
T	Disrupted & mixed sandstones

LEGEND

A	Granite & granite gneiss, basement
C	Paleoregolith
D	Fine orthoquartzite
E	Sericitic,granite pebble sandstone
F	Siliceous, sericitic, conglomeratic sandstone
G	Red, very fine sandstone
H	Siliceous, sericitic, conglomeratic sandstone lacking crossbedding
I	Crossbedded, siliceous,conglomeratic sandstone
J	Pink,feldspathic sandstone
K	Interbedded fine to medium, buff sandstone, very fine, red, micaceous sandstone & dolomite
L	Siliceous, coarse & conglomeratic to fine sandstone
M	Sericitic, volcaniclastic sandstone
N	Chloritic, volcaniclastic sandstone
O	Siliceous, fine sandstone
T	Disrupted & mixed sandstones

Figure 11.

Schematic Palinspastic Stratigraphic Reconstruction
East and Center Portions of Base Line 1
Horizontal scale: 1 inch =340 feet (approx.)
Vertical scale: 1 inch =320 feet (approx.)
See Base Line 1 Geology map legend for rock units

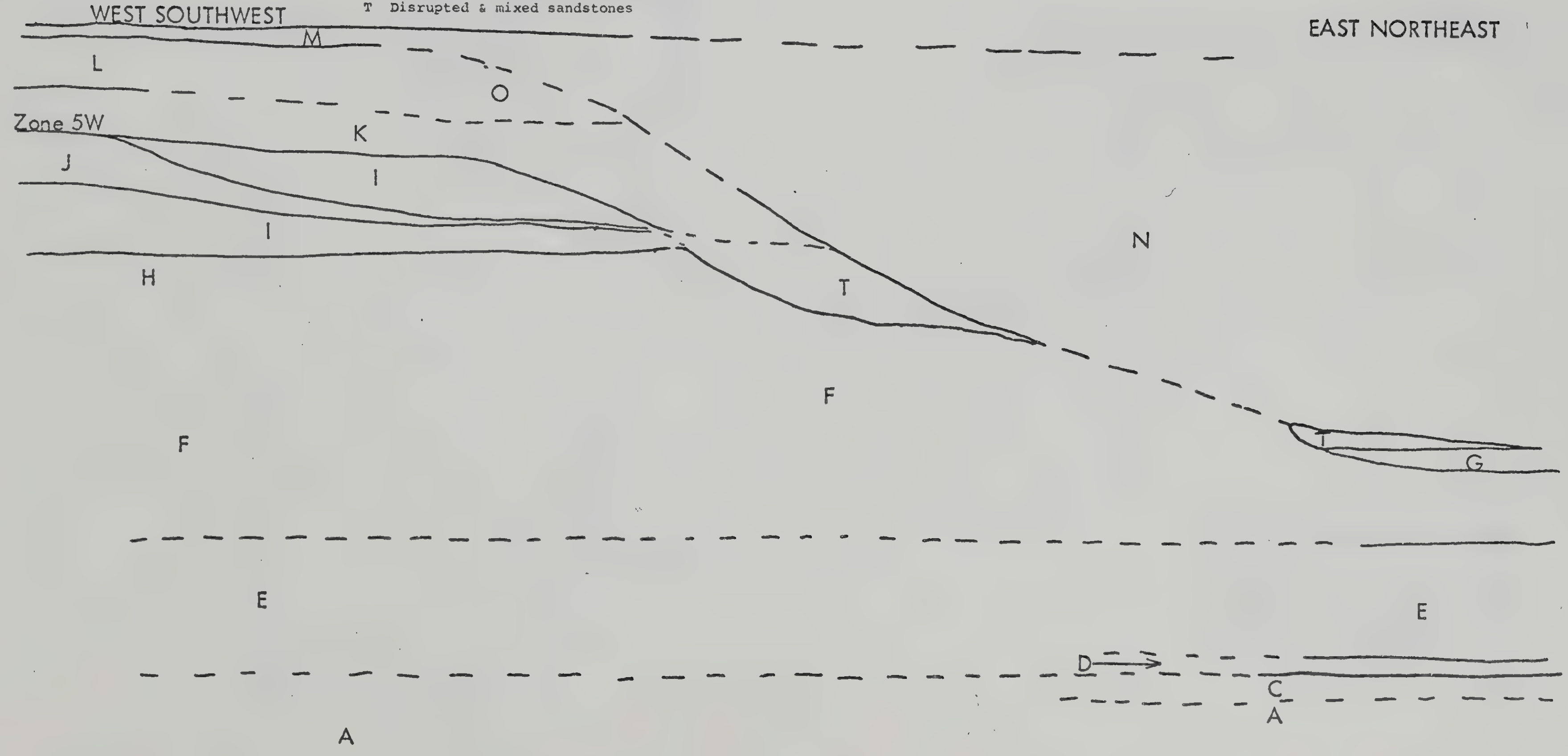
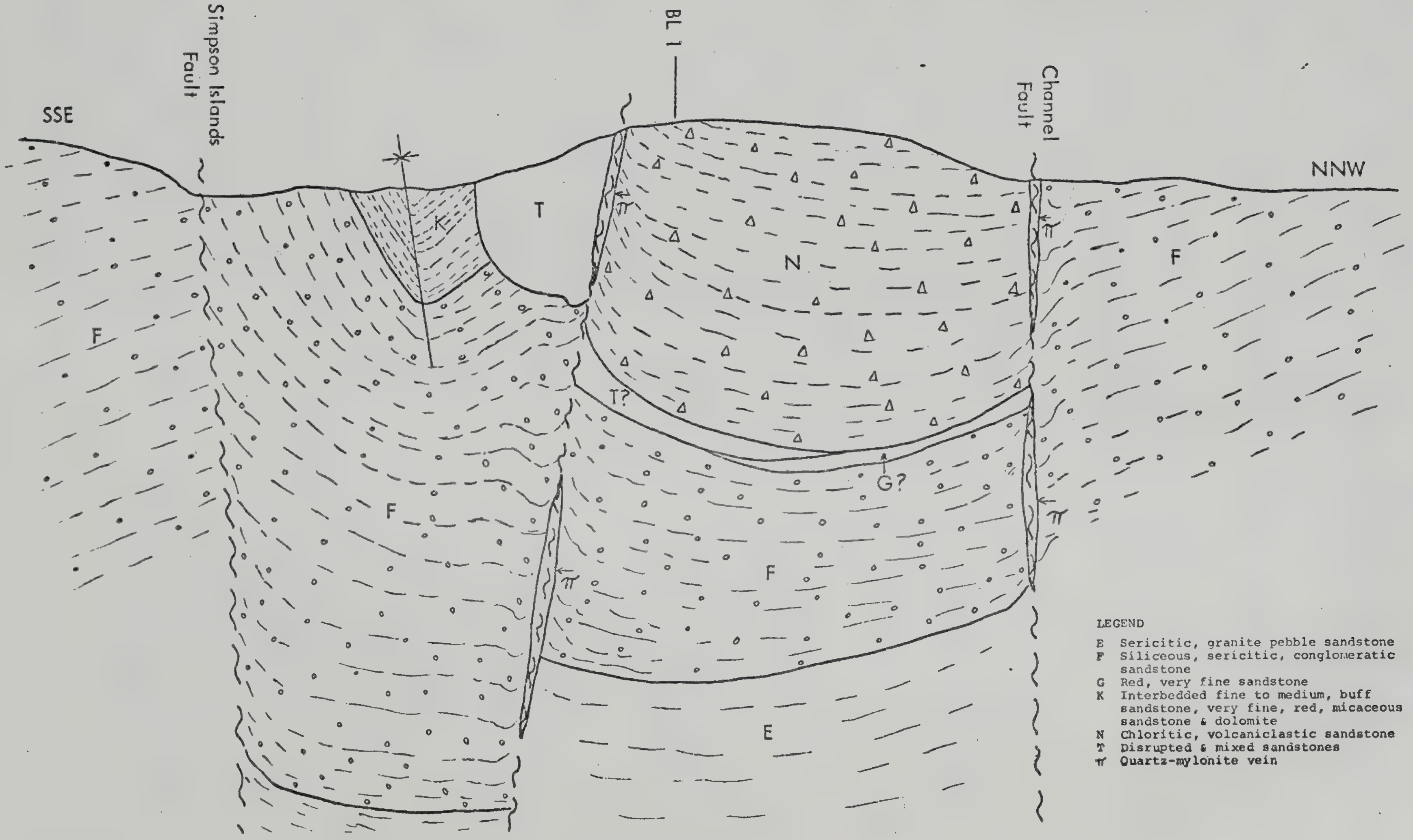


Figure 12.

Schematic Cross Section Normal to Base Line 1 at 60+00 E
Scale: 1 inch = 170 feet; no vertical exaggeration
See Base Line 1 Geology Map for legend


SSE
Simpson Islands Fault
BL 1
Channel Fault
NNW
F
K
T
N
T?
G?
π
F
F
E
F
LEGEND
E Sericitic, granite pebble sandstone
F Siliceous, sericitic, conglomeratic sandstone
G Red, very fine sandstone
K Interbedded fine to medium, buff sandstone, very fine, red, micaceous sandstone & dolomite
N Chloritic, volcaniclastic sandstone
T Disrupted & mixed sandstones
π Quartz-mylonite vein

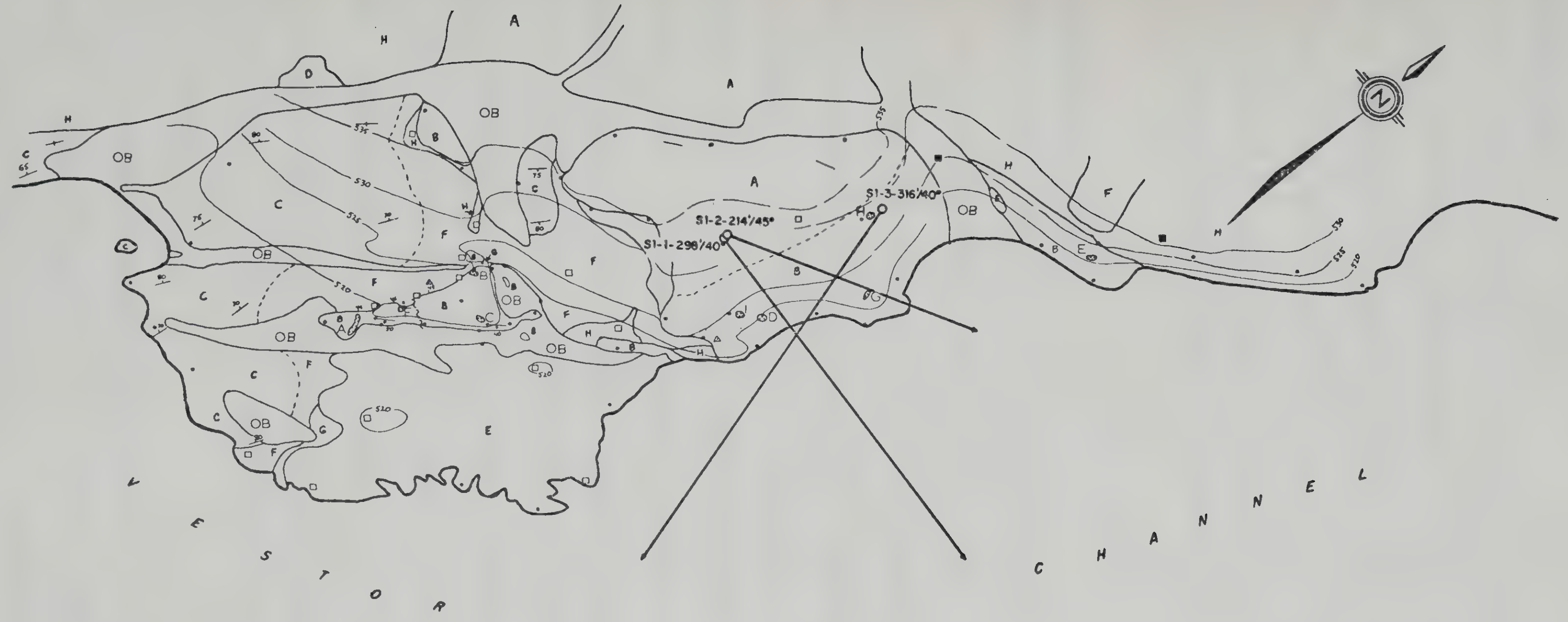
and F as part of a lateral facies variation. Thus the left hand side of figure 11 represents what one might see some distance behind the left hand side of figure 10. The cross section normal to base line 1 presented in figure 12 assumes that the stratigraphic sections in figures 10 and 11 are essentially correct.

The general stratigraphy of the two base line maps and its paleogeographic significance will be discussed in chapter IV.

Geology of Zone 1

Map 12 illustrates the detailed geology of the zone 1 area located on base line 2 (see map 8 for location). This zone is the most geologically complex of the eleven radioactive zones encompassed in the thesis area and illustrates several important field relationships.

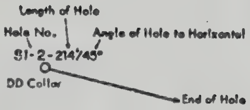
The unbrecciated dark grey siltstone in the southwest side of the area is nowhere seen to contact directly with either Hornby Channel Formation sandstones or bostonite. Instead, a zone of brecciated silstone or siltstone rich breccia everywhere separates the undeformed siltstone from undeformed sandstone or bostonite. A portion of the southwest contact of the massive bostonite stock is marked by a breccia in which bostonite clasts up to a few feet across occur within brecciated siltstone. The close pattern of dolomite filled fractures typical of the zone 1 bostonite (plate 3a) is also seen in the bostonite clasts indicating that fracturing predated brecciation. It appears as if the competant sandstone and bostonite lithologies were brecciated and fragments mixed with brecciated siltstone over irregular areas and along contacts with siltstone, all of which appear discordant and intrusive. The large sandstone outcrop (unit B) on which pits A, B, C and F are located is likely a single, isolated, breccia fragment.



LEGEND

- I Tuffaceous breccia containing fragments of all other lithologies – intrusive
- H Stage 3 breccia: dolomite, siltstone & sandstone fragments in siltstone matrix
- G Stage 3 breccia: bostonite & siltstone fragments in siltstone matrix
- F Brecciated siltstone in siltstone matrix
- E Bostonite; red-brown
- D Dolomite: occurs as clast in stage 3 breccia
- C Siltstone: dark grey to black, laminated to thin bedded
- B Radioactive sandstone of unit A
- A Subfeldspathic to quartzitic, conglomeratic sandstone – Hornby Channel Formation

- Pit or trench
- □ Bench mark
- • Survey station
- ■ Claim post
- △ Instrument set up
- Bedding; dip known, unknown
- Bedding showing current direction and tops
- Fault
- Contour Interval = 5 feet
- Geologic contact; definite and approximate



All holes projected into horizontal plane.

MAP 12

GEOLOGY OF ZONE 1

Simpson Islands Claims

Zone 5 Geology

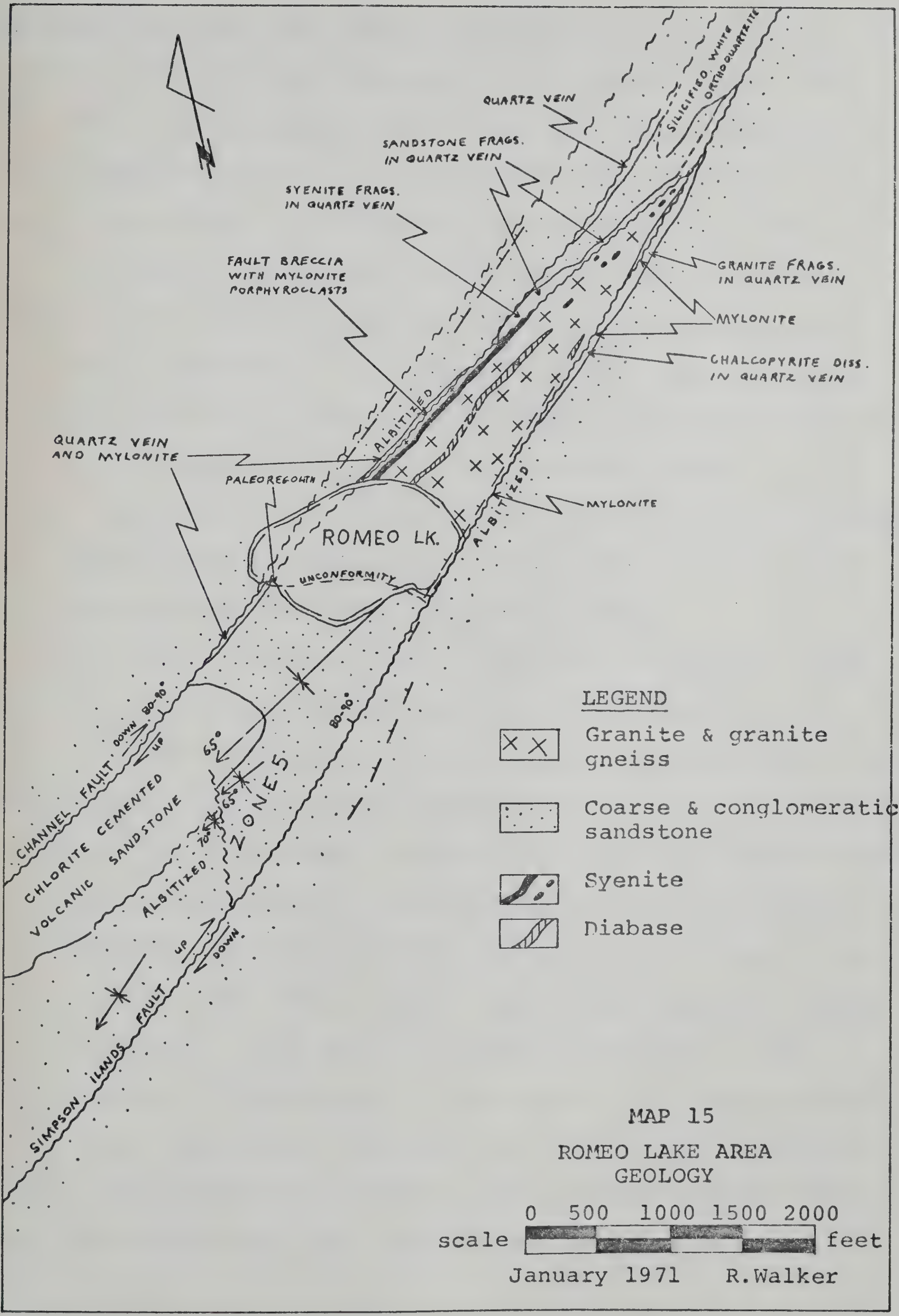
Zone 5, within the base line 1 map area, is the most interesting of the eleven radioactive zones defined in the thesis area. Mineralization within this zone is of higher grade than the other zones. As a result a detailed radiometric orientation survey was conducted over zone five. The geology map of zone 5 (map 13) was made primarily for correlation with the radiometric map (map 14) and as such will be discussed in chapter VI.

Romeo Lake Area Geology

The geology of the northeastern apex of the fault block mapped along base line 1 is presented in map 15 at a scale of one thousand feet to the inch. The area of interest lies between the Channel fault and the Simpson Islands fault near their point of junction 3000 feet northeast of the northeast end of base line 1. Granitic basement rocks underlie a triangular area in the apex of this wedge-shaped fault block. As discussed previously, the unconformity beneath the Hornby Channel Formation, between the Channel fault and the Simpson Islands fault, probably dips about 30° southwest. The unconformity and underlying paleoregolith coincide with a pronounced topographic depression occupied by Romeo Lake due to the erosionally recessive character of the paleoregolith.

The granitic basement rocks exposed in the fault block northeast of Romeo Lake are cut by two discontinuous, northeast striking, diabase dykes. These dykes do not intrude the Hornby Channel Formation which they probably predate.

A thin dyke and several small patches of albite syenite also intrude the granitic rocks immediately northeast of Romeo Lake. This dyke is an extension of the major albite syenite dyke which outcrops north of base line 2. Northeast of Romeo Lake, the present erosion surface seems to


QUARTZ VEIN
SILICIFIED WHITE ORTHOQUARTZITE
SANDSTONE FRAGS. IN QUARTZ VEIN
SYENITE FRAGS. IN QUARTZ VEIN
FAULT BRECCIA WITH MYLONITE PORPHYROCLASTS
GRANITE FRAGS. IN QUARTZ VEIN
MYLONITE
CHALCOPYRITE DISS. IN QUARTZ VEIN
ALBITIZED
QUARTZ VEIN AND MYLONITE
PALEOREGOLITH
ROMEO LK.
UNCONFORMITY
ALBITIZED
MYLONITE
80-90°
DOWN
UP
65°
ZONE 5
65°
70°
CHANNEL FAULT
CHLORITE CEMENTED VOLCANIC SANDSTONE
ALBITIZED
UP
DOWN
SIMPSON ILANDS FAULT
80-90°
LEGEND
Granite & granite gneiss
Coarse & conglomeratic sandstone
Syenite
Diabase
0 500 1000 1500 2000
scale
feet

MAP 15

ROMEO LAKE AREA
GEOLOGY

January 1971 R.Walker

be very close to the upper level of intrusion of the syenite dyke as evidenced by thinness and discontinuity of the intrusive bodies. Here the dyke is composed predominantly of albite (An_{2-5}) which occurs as random, broad laths or rectangles 1 to 3 mm across, some of which are weakly antiperthitic. The intrusive is strongly altered and contains up to several tens of percent secondary carbonate and a little sericite. Primary pyroxene and biotite have been completely altered but are recognizable as pseudomorphs of chlorite and carbonate. Primary magnetite or ilmenite has been pseudomorphed by leucoxene. Like both the syenite and bostonite mapped on base line 2, the syenite here contains a few to several percent apatite as euhedral crystals up to 1x0.3 mm. The northeast end of this syenite dyke ends against the Channel fault which is marked by a large quartz vein containing fragments of syenite.

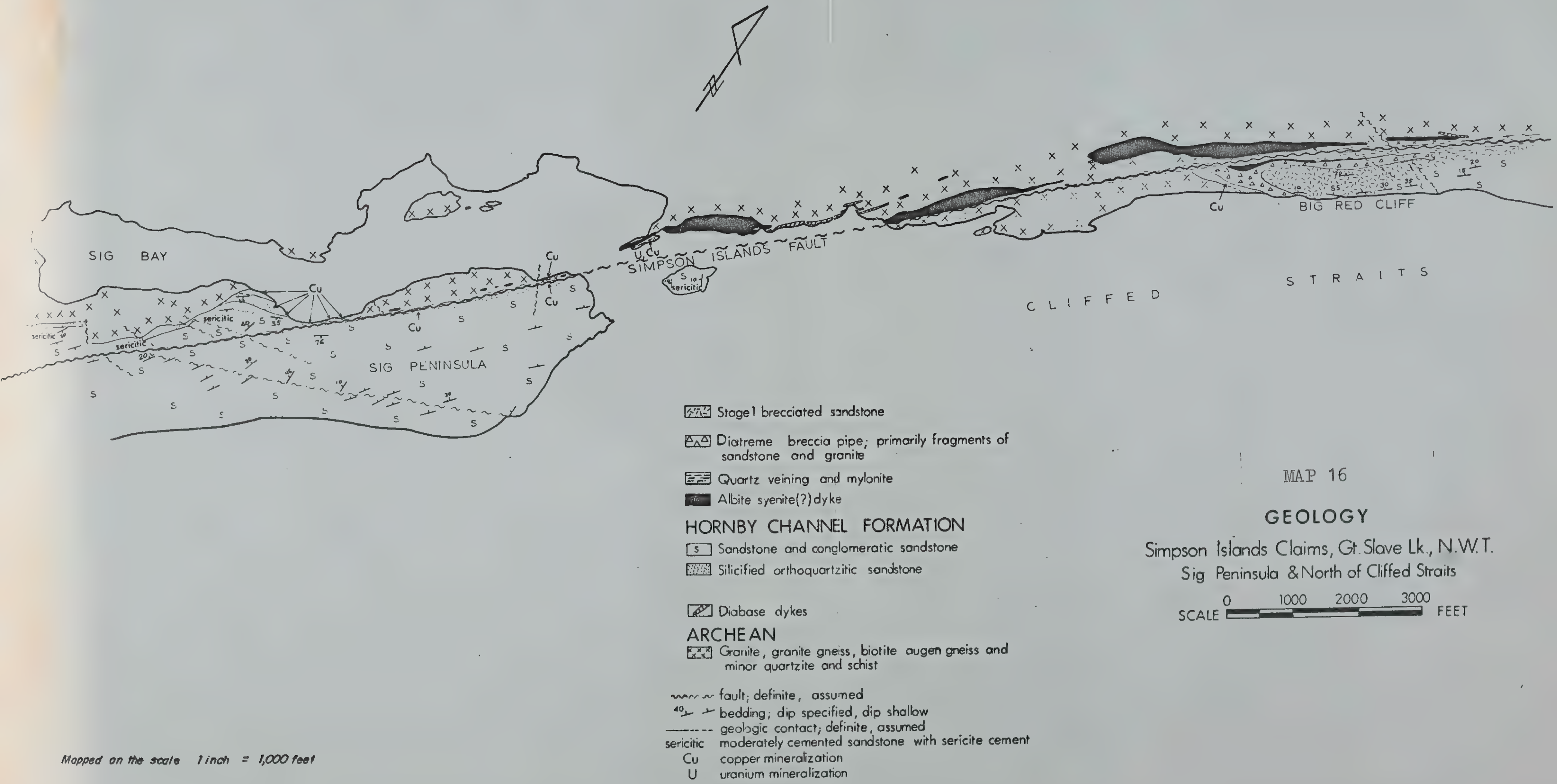
Both the Channel fault and Simpson Islands fault are marked by large white quartz veins which are generally wider (up to 50 feet) near the junction of the two faults. The vein on the Simpson Islands fault contains granite fragments and the adjacent sandstone has been veined by a quartz stockwork. Locally the quartz is mineralized with disseminated chalcopyrite which has partially weathered to malachite and azurite. A narrow, post-quartz mylonite band occurs in this vein on or near its north side. The quartz vein coincident with the Channel fault contains sandstone fragments and in some places is also marked by mylonite. At one place a fault breccia composed of angular mylonite porphyroclasts in a hematitic matrix occurs on the Channel fault. These features indicate repeated movements on the faults involving considerable dilation, mylonitization and brecciation. These faults were active after intrusion of the syenite dyke.

Geology of Sig Peninsula and North of Cliffed Straits

The geology of Sig Peninsula and immediately north of Cliffed Straits is presented in map 16. The area lies along the Simpson Island fault and extends from 3500 feet to 27000 feet northeast of the northeast end of base line 1. The map of the Romeo Lake Area discussed in the previous section provides the geology of the area between base line 1 and Sig Peninsula and thus adjoins map 15 on the southwest side.

Bedding in the Hornby Channel Formation sandstones and conglomeratic sandstones which outcrop on Sig Peninsula and the small island immediately northeast is nearly horizontal to shallowly dipping except locally adjacent the Simpson Islands fault. The sandstones north of this fault on Sig Peninsula represent the basal Hornby Channel Formation and overlie highly altered granitic paleoregolith. The basal fine orthoquartzite unit described for the base line 2 area is represented here but is discontinuous and lensoidal with a maximum thickness of about 60 feet. This lithology locally displays bedding one to three feet thick and rare assymetrical ripple marks. Overlying the basal orthoquartzite is sericitic sandstone, again similar to the base line 2 area. South of the Simpson Islands fault the stratigraphic position of the sandstone is uncertain but likely does not include the lower couple of hundred feet of the Formation. White, silicified sandstone mapped along the Simpson Islands fault is the result of secondary silicification related to the fault and is not equivalent to the basal orthoquartzite.

The Simpson Islands fault, throughout the map area, is characterized by quartz veining, mylonite and silicification of adjacent sandstone. The quartz veins and mylonite usually contain a trace to minor disseminated pyrite and chalcopyrite. Locally sandstone adjacent the fault contains similar mineralization. The basal sandstones in one area on the north


SIG BAY
SIG PENINSULA
SIMPSON ISLANDS FAULT
CLIFFED STRAITS
BIG RED CLIFF
sericitic
Cu
U
s
Stage 1 brecciated sandstone
Diatreme breccia pipe; primarily fragments of sandstone and granite
Quartz veining and mylonite
Albite syenite(?) dyke
HORNBY CHANNEL FORMATION
Sandstone and conglomeratic sandstone
Silicified orthoquartzitic sandstone
Diabase dykes
ARCHEAN
Granite, granite gneiss, biotite augen gneiss and minor quartzite and schist
fault; definite, assumed
bedding; dip specified, dip shallow
geologic contact; definite, assumed
sericitic moderately cemented sandstone with sericite cement
Cu copper mineralization
U uranium mineralization
SCALE 0 1000 2000 3000 FEET

MAP 16

GEOLOGY

Simpson Islands Claims, Gt. Slave Lk., N.W.T.
Sig Peninsula & North of Cliffed Straits

Mapped on the scale 1 inch = 1,000 feet

side of Sig Peninsula contain up to 3% copper minerals (chalcopyrite, bornite, chalcocite, malachite and azurite) both as disseminated interstitial grains and coating cracks and bedding planes. Mineralized sandstone is exposed over an area of about 100 by 50 feet with an average content of less than 2% copper sulphides. The mineralization is probably hydrothermal and related to faults and the syenitic dyke which was likely intruded a short distance below the present mineralized exposure.

The discontinuous syenitic dyke mapped in the area represents the northeastern end of the major dyke described for the base line 2 area. Sporadic outcrops of this dyke may extend a short distance northeast of the map area but a major extension in that direction is not expected. By analogy to the base line 2 and Romeo Lake areas (from which thin sections of the dyke have been examined), the intrusions appear to be melanocratic albite syenite. Chloritized mafics constitute up to 40% of the rock and biotite was found only in a three foot thick marginal phase of the dyke present in one outcrop near the center of the map area. Elsewhere a sulfide-rich, fine grained, grey, altered, marginal phase a few feet thick was seen on the north side of the dyke in a few places. Minor amounts of pyrite and chalcopyrite are locally present in the dyke, especially the north marginal phase, and at one location a very thin pitchblende veinlet was exposed in the dyke by an old rock trench.

The sporadic occurrence of bodies of the syenitic dyke, some as small as a couple of feet across, indicates the dyke in this area is exposed extremely close to its upper level of intrusion and is probably more continuous a short distance below the present erosion surface. Abundant secondary carbonate veining is associated with the intrusions and adjacent rock indicating that carbonatization of rocks between separate outcrops

of syenite is probably related to underlying intrusive material. The carbonate veins appear in hand sample to be dolomite and siderite and commonly contain minor pyrite and chalcopyrite. There appears to have been some locallized cataclasis of the syenitic dyke by movement on the Simpson Islands fault.

North of Cliffed Straits a large crescentic breccia "pipe" is present adjacent the Simpson Islands Fault. This breccia "pipe" cuts Hornby Channel Formation sandstones but locally contains up to 80% angular granitic clasts from the underlying basement rocks as well as abundant to predominant sandstone fragments. Rare clasts resembling the dolomitized banded microbreccia described for base line 2 occur in the pipe as well as rare fragments of siltstone and what appears to be basalt. Except for fragment composition the breccias are similar to the stage 3 breccia with dolomitized comminuted matrix mapped on base line 2. In one location fragments of syenite occur in breccia adjacent an outcrop of the syenite dyke thus again establishing the post-dyke age of the diatreme activity. Sandstone adjacent the breccia "pipe" is weakly brecciated (equivalent to stage 1 brecciated sandstone of base line 2). The thin unit of sandstone on the southwest side of the breccia "pipe" probably is the basal orthoquartzite of the Hornby Channel Formation.

Geology of Ped Peninsula

Ped Peninsula is located on the north side of Preble Island adjacent to the Preble fault (map 7). Although not dealt with in detail, certain aspects of the geology are described as the area contains two radioactive zones (9 and 10) and due to deformational features adjacent the Preble fault.

Ped Peninsula is underlain by sandstones of the Hornby Channel Formation. In general, strike subparallels the Preble fault and dip is gentle to horizontal with some minor undulatory warping towards the northeast. Locally dip may be moderately steep in proximity to the Preble fault but massiveness of the sandstone near the fault makes bedding orientations unreliable and difficult to obtain. The stratigraphic position within the Hornby Channel Formation of the sandstones on Ped Peninsula is uncertain but the lower few hundred feet of the formation are probably not represented.

Generally adjacent to and extending as much as several hundred feet from the overburden covered Preble fault, the sandstone shows abundant evidence of strong cataclastic deformation. This belt contains numerous large lenses of mylonite, cataclasite and breccia attaining maximum dimensions of 1400 x 150 feet. In addition to these lensoid bodies, well defined mylonite bands up to a couple of feet thick are commonly present. These lenses and bands are oriented parallel and subparallel to the Preble fault. The cataclastic rocks are variable in color and are commonly pyritic and chloritic.

The immediate area of zone 10 is included in the belt of cataclastically deformed rocks and is the only area within the belt which was examined closely. A thick band of mylonitic rock is present between zone 10 and the Preble fault while the immediate area of zone 10 is transacted by mylonite bands which are near parallel to the Preble fault. Three lenses of chloritic, cataclastic breccia occur in the zone 10 area as well as two lenses of brecciated sandstone in which abundant aphanitic pink veining may be albitic or cataclastic. The largest of these lenses is 170 by 30 feet and all five lenses occur together within an area of 300 by 60

feet. The long axis of this area as well as the long axes of the individual lenses subparallel the Preble fault.

The immediate area of zone 9 is underlain by flat-lying, nearly undisturbed sandstone and conglomeratic sandstone typical of the Hornby Channel Formation. Quartz veins and occasional thin mylonitic shears transect the sandstone with a preferred northeast strike. Locally the sandstone is silicified adjacent such shears.

The strike of steeply dipping joints measured on zone 9 define two orthogonal sets. Joints of the most prominent set strike between 30° and 50° whereas joints of the less prominent set strike between 120° and 140°. Two, orthogonal, steeply dipping joint sets defined on zone 10 are similar but azimuths of strike are somewhat greater at 40° to 70° and 150° to 165°. As the strike of the Preble fault is 50°, the two joint sets of zones 9 and 10 are sub-parallel and sub-normal to the Preble fault. As the strike of the mylonite bands parallels the northeast striking joints and quartz veins it seems reasonable to infer that the northeast striking joints originated as shear joints cogenetic with the Preble fault. The second joint set has an orientation inconsistent with either conjugate shears or tensional joints related to dextral shear on the Preble fault and was probably generated by an unrelated stress field. This set was most likely formed at the time of the younger northwest striking sinstral faults which they parallel.

The major deformational features found adjacent the Preble fault on Ped Peninsula appear to have been generated by cataclastic deformation during transcurrent movement along the Preble fault. This style of deformation is inconsistent with the later normal movements of the McDonald system faults. An overburden covered, linear, topographic

low just south of the erosionally resistant, cataclastically deformed rocks described above likely coincides with the plane of normal movement which transected or paralleled the older zone of deformation produced by continued transcurrent movement.

No diatreme pipes similar to those of the Simpson Islands fault system were found on Ped Peninsula although Reinhardt (1972) described such breccias further southwest along the Preble fault system. Perhaps the brecciated sandstone lenses with pink aphanite veining described for zone 10 represent an incipient stage of breccia pipe formation. Near the northeast end of Ped Peninsula an assistant located a small stock of reddish aphanite about 500 feet from the Preble fault. A hand sample of this rock closely resembled the bostonite of the base line 2 area except that it lacked a megascopically visible trachoidal texture. Similar, possibly igenous, rocks were described by Reinhardt (1972) to the southwest associated with breccias.

CHAPTER IV

STRATIGRAPHY OF THE HORNBY CHANNEL FORMATION

Introduction

The Hornby Channel Formation is found throughout the south side of the East Arm of Great Slave Lake. This basal formation of the Great Slave Supergroup unconformably overlies Archean plutonic and high grade metamorphic rocks and the Lower Aphebian Wilson Island Group. Hoffman (1968) concluded that the Hornby Channel Formation exposed on Union Island unconformably overlies the Union Island Group but the evidence is equivocal.

Throughout the East Arm the Hornby Channel Formation is composed almost entirely of coarse and conglomeratic subarkose. This submature to mature sandstone is characterized by festoon crossbeds which indicate unidirectional sediment transport down the axis of the East Arm from northeast to southwest (figure 13). The formation attains its maximum thickness at the southwest end of the East Arm, in the thesis area, where 3,000 to 5,000 feet are preserved and the top of the formation is not exposed. Towards the northeast, the formation thins to 740 feet at the type section 75 miles from the thesis area and perhaps 150 feet at the northeast end of the East Arm 135 miles from the thesis area (Hoffman,1968).

The formation becomes finer grained towards the northeast and, in the type section at Lac Duhamel, is characterized by thin beds of pebbly, coarse sandstone separated by partings of shale and siltstone. Most beds in the type section contain festoon crossbedding and ripple marked tops are common. In contrast, the formation in the thesis area is much more extensively conglomeratic, lacks shale and siltstone partings and is almost completely festoon crossbedded without continuous bedding planes.

Hoffman (1968) concluded "the substantial thickness, uniform lithology,

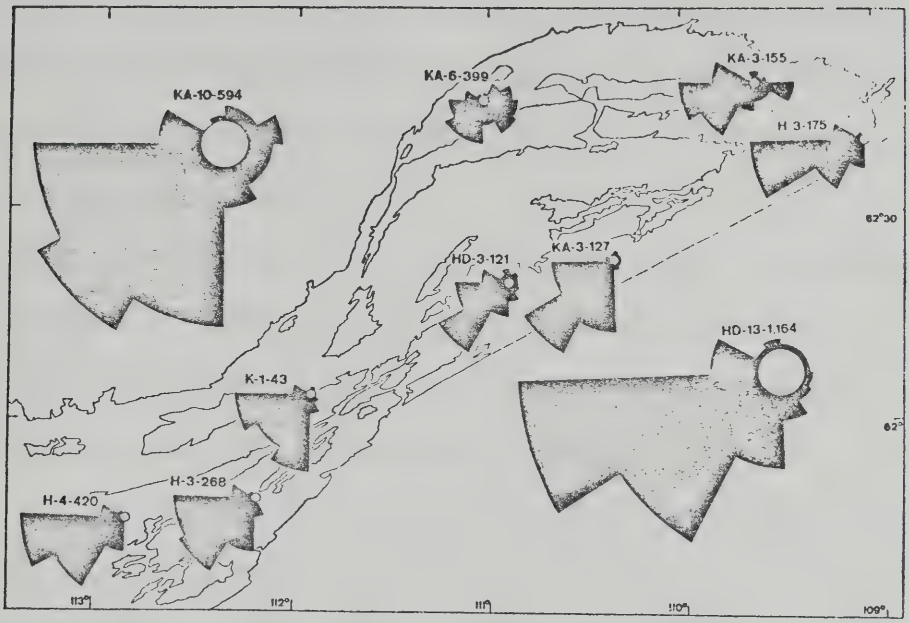


FIG. 13. Paleocurrent rose diagrams of crossbedding in sandstones of the first depositional stage. H = Hornby Channel Formation; D = Duhamel Formation; K = Kluziai Formation; and A = Akaitcho River Formation. First numeral is the number of sampling locations; second numeral is the number of measurements. Large rose diagrams are total from all locations. From Hoffman (1968).

ubiquitous festoon crossbedding, presence of mudcracks, and the texturally mature but mineralogically submature nature of the formation indicate a non-marine origin. The absence of fining-upward alluvial cycles, the abundance of conglomeratic sandstone, the thin lenticular bedding, the absence of channel fill deposits and the uniformity of crossbed orientation suggest deposition from braided rather than meandering rivers."

As pointed out by Hoffman (1969), the Hornby Channel Formation is undoubtedly diachronous and transgressed from southwest to northeast. The sands and gravels were largely derived from the Archean crystalline rocks of the Slave craton on which they were deposited.

Base of the Hornby Channel Formation Outside the Thesis Area

The rock types which comprise the basal beds of the Hornby Channel Formation vary from place to place, a fact which has led to erroneous conclusions in the literature regarding the geology of the Simpson Islands Area. In the type section at Lac Duhamel, the Archean basement is overlain

by 4 feet of conglomerate with a maximum clast size of 0.5 feet. Clasts are predominantly quartz with minor feldspar and granite pegmatite. Sandstones and conglomeratic sandstones typical of the formation occur above the basal conglomerate.

The only other exposure of the sub-Hornby Channel Formation unconformity reported in the literature occurs on a small island in Inconnu Channel, south of Wilson Island. This island, referred to as Contact Island in this report, is located about 12 miles west of the northwest corner of the thesis area and is shown on map 6. Here, altered granitic rock is overlain by 5 feet of medium grained, hematitic, quartz sandstone followed by 40 feet of stromatolitic dolomite. Between this dolomite unit and the Hornby Channel Formation sandstones, 20 feet of section are covered by overburden. A detailed description of the Contact Island section is included in appendix 1. The dolomite and overlying sandstone beds appear conformable and both Hoffman (1968) and Reinhardt (1969b) concluded that the dolomite unit comprises the base of the Hornby Channel Formation. The writer agrees that this interpretation is probably correct, although it is by no means proven.

Hoffman (1968) and Reinhardt (1969b and 1972) correlated the basal dolomite unit on Contact Island with siltstone and dolomite exposed along Vestor Channel in the thesis area and thus they both concluded that a unit of dolomite and siltstone comprises the basal beds of the Hornby Channel Formation in the Simpson Islands area. This conclusion appears erroneous, as several examples of Hornby Channel Formation sandstones which directly overlie granitic basement rocks have been documented as little as 200 feet from major exposures of dolomite and siltstone. The siltstone and dolomite exposed along Vestor Channel are believed to belong to another formation which is possibly younger than the Hornby Channel Formation,

as discussed in chapter V. Reinhardt (1972) similarly considered a unit of dolomite, siltstone, quartzite and volcanic rock exposed in a narrow fault block along Preble Channel at the southwest corner of the thesis area to comprise the basal beds of the Hornby Channel Formation. This is considered unlikely and the rocks in question are thought to probably belong to the Wilson Island Group, as discussed in chapter 3.

Sub-Hornby Channel Formation Unconformity in the Thesis Area

The unconformity which separates the Archean basement from the overlying Hornby Channel Formation on South Simpson Island is the largest section of the unconformity preserved in the western East Arm. It cannot be seen to outcrop anywhere on South Simpson Island due to its erosionally recessive character. Small sections of the unconformity are exposed between faults of the Simpson Islands system along the northwest side of the main Hornby Channel Formation outcrop area. Four known exposures in the thesis area are listed below:

1) West end of base line 2 (map 8)
2) Base line 2, 58+00W, 2+60N (map 8)
3) West side of Romeo Lake (map 10)
4) South shore of Sig Bay (map 16)

In addition to these exposures, the unconformity was intersected in drill core on zone 7 (map 8). In all five locations, a basal, silicified, fine orthoquartzite overlies extremely altered granitic and gneissic rock in which all the mafics and much or all of the feldspar have been replaced by pale green sericite (plate 4; a,b). On surface, this altered granitic and gneissic rock presents an extremely weathered and crumbly aspect which, in extreme cases, precludes the removal of a hand sample intact. Northeast of Romeo Lake, where the unconformity is assumed but not exposed,

the nearest granitic outcrops present a similar character and it is felt that the extremely weathered nature of such granitic outcrops can be used to indicate proximity to the unconformity. The granitic rock which underlies the Hornby Channel Formation on Contact Island appears similarly altered and weathered.

Altered granite beneath the unconformity is thought to represent a paleoregolith which developed subaerially, immediately prior to deposition of the Hornby Channel Formation. In all instances, the paleoregolith grades into unaltered granitic rocks within a few tens of feet normal to the projection of the overlying unconformity. In many respects, the paleoregolith is similar to that underlying the Huronian succession in the Elliot Lake Area of Ontario (Roscoe, 1968 and personal observation). Granite pebbles in the lower portion of the Hornby Channel Formation usually show sericitic alteration similar to that of the paleoregolith. It is probable that paleoregolith beneath the unconformity on South Simpson Island is responsible for its erosionally recessive character.

The paleoregolith locally appears sheared due to incompetent behaviour during folding of the overlying sandstones. It is probable that during this folding the paleoregolith locally acted as a zone of décollement. In other places, no significant shearing took place as evidenced by a drill core intersection from zone 7 in which paleoregolith with completely sericitized feldspar showed intact gneissic foliation at a high angle to an abrupt contact with overlying orthoquartzite. Locally some shearing of the paleoregolith, has resulted from movement on adjacent faults. Silicification of the paleoregolith, in the form of a close network of quartz veinlets, was only seen adjacent faults as on the west side of Romeo Lake.. There, minor pyrite is also associated with the remobilized silica.

The sub-Hornby Channel Formation unconformity appears to show only small scale irregularities within the thesis area with the exception of the area immediately north of the west end of Paddlefish Lake on South Simpson Island (map 7). Here the basement outcrop extends in a nose about 600 feet east of its general northwest trend into the area underlain by Hornby Channel Formation. A topographic ridge about 100 feet high on the pre-Hornby Channel Formation erosion surface would be sufficient to produce such a deviation in the trend of the unconformity. Such a ridge is consistent with the presence of a large northeast trending diabase dyke system in the basement in line with the abrupt south side of the basement ridge. This diabase dyke system likely predated the Hornby Channel Formation and would have existed as a topographic low prior to deposition of the overlying sandstones.

Stratigraphy of the Hornby Channel Formation in the Thesis Area

The stratigraphy of the lower several hundred feet of the Hornby Channel Formation is similar throughout the thesis area. The section above this lower several hundred feet is rather uniform away from major northeast striking faults but may be quite variable near such faults. Detailed stratigraphic sections are provided in appendix 1. A generalized stratigraphic section of the Hornby Channel Formation in the Simpson Islands area is described in table 4.

Table 4: Generalized stratigraphic Section, Hornby Channel Formation, Simpson Islands Area

Unit 111	
approx. 2500 to 4500 feet thick	Strongly (silica and sericite) cemented sandstone to conglomeratic sandstone: white to buff, medium to very coarse with trace to 30% granules and pebbles, poorly sorted, abundant festoon cross-beds, common black hematite rich heavy mineral laminations, 5 to 15% feldspar, oligomictic gravel fraction composed of quartz and quartzite clasts, characterized by rapid vertical and lateral grain size variations on an outcrop scale.
	——— very gradational contact ———
Unit 11	
approx. 500 to 800 feet thick	Sericite cemented, slightly conglomeratic sandstone: buff to brown, moderate strength of cement allows a sandpaper-like weathering surface, generally lacks visible crossbedding, massive, 10 - 30% feldspar, lacks hematite laminations, contains common granitic and other lithic clasts towards base, generally shows bimodal sorting with less than several percent pebbles in very coarse to medium, moderately sorted matrix. Locally, especially towards the base, polymictic conglomeratic and conglomerate lenses may be present, granitic debris is mostly highly altered and difficult to distinguish except in drill core.
	——— sharp contact ———
Unit 1	
variable thickness 0 to 60 ft.	Fine, well sorted, silicified orthoquartzite: white to pale reddish due to hematite stain, well rounded grains, very strongly cemented, massive to rarely thin bedded with ripple marks, no hematite laminations.
	——— sharp contact - unconformity ———
0 to 30? feet thick	Highly altered, pale green granitic, paleoregolith.

The descriptions given in table 4 are very generalized and express the common range in lithologic parameters. At any given spot the rock may differ considerably from the above description but overall the units are recognizable by the given features.

The succession of the above three sandstone units over basement has been recognized on both base lines, Sig Peninsula, the south side of the west end of Vestor Channel, the northwest corner of sandstone on South Simpson Island and both north and south of Paddlefish Lake. In addition to these established basal sections it is likely that much of the sandstone between zone 5 and the basement to the north belongs to the sericite cemented unit 11 as well as the sandstone immediately south of the Simpson Islands fault on base line 1 southwest of zone 5 where the fault meets Great Slave Lake. The basal orthoquartzite (unit 1) may be represented north of Cliffed Straits.

Depositional Environment

The basal fine grained orthoquartzite (unit 1 of table 4) reflects a different depositional environment than the overlying conglomeratic sandstones which regionally characterize the Hornby Channel Formation. The characteristics and field relations of the basal sandstone can be accounted for in the context of an aeolian origin. The underlying paleoregolith and overlying braided stream deposits both indicate a subaerial environment. The preservation of easily eroded regolith beneath the unit and absence of granitic debris in the orthoquartzite indicate a lack of scouring at the base of the orthoquartzite. The good sorting and fine grain size characteristic of the unit as well as the occasional assymetric ripple marks are consistent with dune sands. The highly variable thickness of the unit (0 to 60 ft.) and the occurrence of

occasional lenses of fine orthoquartzite isolated within the immediately overlying conglomeratic sandstone (e.g. base line 2, 68+00W, 2+40N, map 8) are also consistent with aeolian dunes. Hoffman et al (1970) reported the occurrence of aeolian sands in the Odjick Formation at the base of the Epworth Group, a formation which they correlated with the Hornby Channel Formation.

The conglomeratic sandstones of unit 11 and 111 in the general stratigraphic section (table 4), were most likely deposited by braided streams as proposed by Hoffman (1968) for the reasons previously quoted. Unit 11 is less mature than unit 111. The clastic material of unit 11 was deposited close to its source as evidenced by its altered granitic component derived from the paleoregolith below the unconformity. Where this regolith was protected by the basal orthoquartzite in the Simpson Islands area or the basal dolomite on Contact Island it was preserved. Where unit 11 lies directly on the basement one would expect the regolith to have been partially or completely eroded as in the type section at Lac Duhamel where polymictic conglomerate directly overlies basement. Local lenses of polymictic conglomerate containing granitic clasts are present near the base of unit 11 in several places in the thesis area as well as on Contact Island. The proportion of granitic debris in unit 11 decreases upward indicating increasing distance from source as the thin edge of the fluvial sandstone prism migrated northeast. The abundant sericite cement characteristic of unit 11 is most likely derived in part from the altered feldspathic components of the regolith as well as from post-depositional alteration of the more abundant clastic feldspar associated with the granitic clasts. The very gradational contact between unit 11 and unit 111 corresponds in part to a decrease in the amount of sericite cement and feldspar, and a corresponding increase in silica cement

in the more mature sandstones of unit lll.

Another characteristic of unit lll consistent with its greater maturity is the presence of ubiquitous hematite-rich heavy mineral laminae which commonly define foresets in the extensively cross-bedded sandstones. Individual black hematite laminae range up to 1 cm thick and usually a number of associated bands are interlaminated with quartzo-feldspathic bands of similar or greater thickness. In a single occurrence hematite laminae may comprise up to 50% of the sandstone for a thickness of up to one foot (plate 1b). The hematite laminae are composed mostly of very fine to fine, well rounded and well sorted hematite grains with high sphericity (plate 9h). The grain size of the intercalated quartzo-feldspathic laminae and any quartz or feldspar grains within the hematite laminae is much larger than the associated hematite grains. The quartz and feldspar grains are less well sorted. The hematite bands contain up to several percent partially metamict zircon (x-ray diffraction analysis of heavy mineral separates) and occasional grains of monazite. Consequently these hematite laminae are moderately to strongly radioactive, an aspect which will be discussed in chapter Vl. It is concluded that the hematite laminae were originally magnetite microplacers rich in thorium-bearing detrital minerals and with a fine grain size reflecting hydraulic equivalence with associated quartz and feldspar grains. Oxidation of original magnetite could have been the result of diagenetic or ground water processes or prehnite-pumpellyite-quartz facies burial metamorphism.

Unit lll of the generalized stratigraphic section is also characterized by ubiquitous festoon crossbeds which indicate a uniform current direction from the northeast. Scour gravel occasionally occurs at the base of some cross-sets (plate 1a). Cross-sets vary in size from a few inches to several tens of feet across; the latter suggest dune bottom

forms indicative of water velocity in the upper part of the lower flow regime. No evidence was seen of upper flow regime depositional structures but this may reflect only an inability to detect them due to a lack of bedding plane fissility and the difficulty of tracing bedding on the scale of antidunes over the lichen covered outcrops. Due to the extensive crossbedding and abundant scour surfaces, bedding laminations defined by grain size variations are laterally very discontinuous.

With respect to recognizable bedding planes units 11 and 111 are massive to thick bedded (a few feet thick). Bedding planes are generally much more readily recognizable away from major northeast striking faults. Sandstones within about 1000 feet of major northeast striking faults generally appear more strongly indurated. The apparent massiveness of fault-proximal sandstones is likely due to silicification as discussed in chapter V. The greater induration of the sandstones close to faults has made bedding orientations very difficult to recognize in most of the areas included within the two base line maps. Most of the recorded bedding attitudes are based on extremely local features such as grain size laminations, hematite laminations and scour surfaces and thus may be biased by depositional inclination. Unit L on base line 1 (map 10) is an example of a map unit with well defined contacts within which measured bedding attitudes appear to systematically deviate from the true strike as a result of primary inclination of cross-sets.

The base line 1 map area is an example of an area adjacent major northeast striking faults in which the stratigraphy of the Hornby Channel Formation, above about 600 feet from the base, differs considerably from the general stratigraphic section described in table 4. The unusual rock types present in the base line 1 map area have been described and their stratigraphic relationships discussed in chapter 111. Generally the

unusual rock types in this area comprise fine grained, commonly micaceous and hematitic sandstones, minor sedimentary dolomite and sandstones rich in volcanic detritus. Unusual rock types the same as or similar to some of those present in the base line 1 area have been seen in other places in the Simpson Islands area but only adjacent major northeast striking faults.

Soft sediment deformation features are common in the Hornby Channel Formation sandstones along the Simpson Islands and Channel faults but are rare or absent away from major northeast striking faults. The most common penecontemporaneous deformation features are chaotically disrupted hematite laminae (plate 1; b,d) and areas of irregularily mixed sandstones of contrasting grain size (plate 1; c,d). The largest such area of disrupted and mixed sandstone types has been described as unit T in the base line 1 map area and is considered a probable slump structure. The presence along major northeast striking faults of unusual fine grained sandstones and minor dolomite combined with soft sediment deformation features suggests that the McDonald fault system was active during deposition of the Hornby Channel Formation. The facies variations along the faults are indicative of fault controlled topographic depressions consistent with transcurrent, not normal movement.

The localized occurrences of volcaniclastic sandstones mapped in the Hornby Channel Formation near the Channel fault and Simpson Islands fault comprise the first reported evidence of volcanic activity during deposition of the lower part of the Hornby Channel Formation. An occurrence of volcaniclastic sandstone within the Hornby Channel Formation was mapped by the writer on a small island in Inconnu Channel about 8 miles northwest of the northwest corner of the thesis area. This volcanic sandstone is quite similar to that mapped as unit N on base line 1 (map 10) and,

like the base line 1 occurrence, lies adjacent a major northeast striking fault of the McDonald system.

Bedrock trenches and diamond drill holes on zone 5, base line 1 (map 10) and zones 2 and 7, base line 2 (map 8) revealed the presence of minor amounts of pale green mudstone which occurs both as occasional lenses and as thumbnail-sized chips in the conglomeratic sandstones of stratigraphic units 11 and 111 of the Hornby Channel Formation. A similar thin bed of dolomitic sericite is exposed on the north side of Con Peninsula (map 7, south of the west end of base line 1). This pale green mudstone is composed of sericite (muscovite or illite by X.R.D. analysis) which contains extremely fine disseminated impurities which appear to be mostly iron oxide. A relict spherulitic texture was evident in two thin sections of this rock type from zone 5 (plate 4h). Petrographically the mudstone appears very similar to sericitized volcanic fragments from map unit M and the sericitic margin of map unit N, both on base line 1 (plate 4g). This similarity together with an absence of detrital quartz and feldspar in the sericite lenses suggests that they represent locally preserved lenses of altered air-fall tuff. Such sericitic mudstone was not seen in sandstone away from the Simpson Islands fault system with the possible exception of one occurrence reported just south of Bun Lake (map 7). The largest of the pale green mudstone lenses was exposed by trenching on zone 5 where a 10 foot thickness is indicated; however, in this area the lenses appear tectonically squeezed and are not necessarily parallel bedding. The presence of localized lenses and chips of sericite altered tuff in the Hornby Channel Formation suggests that some of the sericite cement in the normal sandstones may represent reworked altered tuff. This is especially likely in the case of map unit M, base line 1.

It is reasonable to assume that the sporadic minor volcanism which occurred during deposition of the Hornby Channel Formation in the Simpson Islands area was localized along major faults of the McDonald system. Hoffman (1968) reported the occurrence of an 8 foot thick bed of waterlain tuff very near the top of the Hornby Channel Formation in the type section at Lac Duhamel. In comparison to the volcanic material in the thesis area, this tuff bed is much younger considering its higher stratigraphic level and the diachronous nature of the Hornby Channel Formation.

Conclusions

The Hornby Channel Formation is a regionally extensive unit of submature to mature sandstone and conglomeratic sandstone. This formation lies at the base of the Great Slave Supergroup and unconformably overlies Archean granitic and high grade metamorphic rocks or Lower Aphebian sedimentary and volcanic rocks. The Hornby Channel Formation was deposited after development of a subaerial regolith on the underlying granitic basement. The formation is diachronous, transgressed from southwest to northeast and was deposited from braided streams flowing southwest down the axis of the East Arm.

On Contact Island, south of Wilson Island, a 40 foot thick unit of stromatolitic dolomite appears to lie near the base of the Hornby Channel Formation. In the Simpson Islands area the basal unit of the formation is composed of fine orthoquartzite of probable aeolian origin which is up to 60 feet thick. The dolomite and siltstone exposed along Vestor Channel are allochthonous due to faulting and diatreme activity and came from a formation other than the Hornby Channel Formation.

The conglomeratic sandstones which directly overly the basal ortho-

quartzite contain altered granitic debris and abundant sericite cement reflecting a derivation from nearby granitic basement and paleoregolith. With increasing distance from the base of the formation, the character of the sandstone reflects increasing distance from the source. Rock types which are unusual for the Hornby Channel Formation in the thesis area are present along major McDonald system faults. These facies variations as well as penecontemporaneous deformation features suggest transcurrent movement occurred on the McDonald fault system during deposition of the Hornby Channel Formation.

Sporadic volcanism occurred during deposition of the formation and was probably localized along major northeast striking faults. This volcanism gave rise to localized volcaniclastic units and minor preserved air-fall tuffs. Reworking of volcanic material likely added a tuffaceous component to some sandstones.

CHAPTER V

INTRUSIONS, DIATREMES AND ALTERATION

Albite syenite Dyke

A large dyke of albite syenite up to 600 feet wide, transects the Archean basement rocks along the north margin of the thesis area (map 7). This is a portion of a 16 mile long, east-northeast striking dyke which extends from a point 5 miles west-southwest of the thesis area (map 4) to a point just north of Cliffed Straits in the thesis area. Segments of this dyke are represented on maps 8, 10, 15 and 17.

The dyke in the thesis area is composed principally of hematite stained, weakly antiperthitic albite with perhaps 10 to 20% mafics represented by altered pyroxene, hornblende and primary biotite. Apatite is a characteristic accessory present in amounts up to a few percent. More complete descriptions are provided in chapter 111. The name albite syenite reflects the present petrographic character of the rock but weak sericitization and epidotization of the plagioclase suggests that it may represent an altered syenodiorite. Burwash (personal communication) found the dyke to be nepheline normative at one location in the thesis area. Baragar (1962) has described the dyke from its southwest end on Easter Island. There the dyke dips 50° southeast and is differentiated across strike. A footwall phase contains 30 to 40% olivine and a few percent pigeonite. The main phase contains augite and no olivine but olivine may reappear in a narrow hangingwall phase. The proportion of potash feldspar to total feldspar increases away from the base whereas biotite comprises 5 to 10% of the rock throughout. The dyke rock lacks quartz and Baragar concluded that it is best classified as a monzonite.

From a point north of Eagle Bay (map 7) to its northeast extremity, the dyke is discontinuous at the present erosion surface with some

occurrences being thin dykes and pods as little as a few feet across (maps 15 and 16). This discontinuous portion of the dyke is commonly melanocratic and strongly dolomitized as are immediate wall rocks. Strong carbonate veining and alteration of rocks, particularily diabase, between exposed segments of the dyke suggests that the dyke intruded close to surface in many places and is probably continuous a short distance below the present erosion surface.

Minor sulphide mineralization is common in the syenite dyke throughout its length. Iron sulphides and chalcopyrite typically occur in narrow carbonate altered marginal phases of the dyke in the thesis area. At the southwest end of the dyke Baragar (1962) has described sub-economic occurrences of niccolite, gersdorffite, chalcopyrite, pyrite, pyrrhotite and silver disseminated in carbonate altered zones 10 to 15 feet thick in both margins of the dyke as well as in quartz-carbonate veins adjacent the dyke contacts. Chalcopyrite appears to be more common in the dyke near both ends whereas nickel sulphides have been found only in the southwest end where they are associated with olivine rich differentiates. The several occurrences of copper and iron sulphide mineralization in the area of Romeo Lake, Sig Peninsula and Cliffed Straits which have been described in chapter 111 are possibly related to the syenite dyke which reached its upper level of intrusion in this area. It is noted that some, indeed the best, of this mineralization occurs in Hornby Channel Formation sandstones (map 17).

The albite syenite dyke appears to have intruded along major northeast striking faults of the Simpson Islands fault system. The conformity of the dyke to these faults in the thesis area suggests that the faults were active prior to dyke intrusion. North of base line 2 a major splay of the Simpson Islands fault system parallels and obliquely transects the

dyke (map 7). The dyke shows an apparent dextral offset of two thousand to several thousand feet. Immediately northeast of Romeo Lake a segment of the dyke parallels and is obliquely truncated by the Channel fault. At the point of truncation a giant quartz vein which lies on the fault contains fragments of chloritized syenite (map 15). These examples indicate that the transcurrent faults which controlled emplacement of the dyke remained active after cooling of the dyke.

Bostonite

Several small stocks and dyke-like bodies of bostonite occur in the base line 2 map area between 16+00W and 22+00E (map 8). The bostonite (plate 4c) is composed of very fine to fine, trachoidal, hematite stained albite which has characteristically been moderately to strongly carbonated (dolomite by field identification), variably sericitized and locally chloritized. Apatite is a characteristic accessory present in amounts up to 10%. Thin section staining revealed no potassium feldspar and only trace to minor quartz is present. A more detailed description is provided in chapter 111.

The bostonite definitely intruded sandstones of the Hornby Channel Formation. Contacts between sandstone and bostonite are sharp and discordant. In one place (base line 2, 1+00E, 2+00N) the sandstone intruded by bostonite was extensively brecciated with the separation and engulfment of large sandstone blocks in the adjacent bostonite (plate 3b).

The several separate bodies of bostonite exposed in the base line 2 area probably are, or were prior to diatreme activity, interconnected within several hundred feet of the present erosion surface. The largest outcrop of this hypabyssal intrusive occurs in the vicinity of 20+00E, 5+00S and is several hundred thousand square feet in area. Several small

outcrops of bostonite, a few of which may be breccia fragments are scattered between this stock and the large dyke-like bostonite body centered on 0+00, 2+50N. Similarly, three very small bostonite outcrops are scattered between the above mentioned dyke-like bostonite intrusion and a bostonite stock on zone 1. 308 feet of drilling on zone 6 produced three intersections totalling 31 feet of completely sericitized and dolomitized bostonite similar to altered marginal phases of bostonite encountered in drilling on zones 1 and 3. These numerous small occurrences of bostonite are suggestive of dyke and finger-like intrusions, of bostonite above a larger more continuous bostonite body. It appears that part of this larger bostonite body was intersected in drill core on zone 3 just 30 feet below the sandstone outcrop. Here the bostonite differs from outcrops in that it is medium-grained away from the margin (compared to fine and very fine in outcrop) and dark greenish grey due to appreciable chlorite which is lacking in the red-brown outcrops. This zone 3 drill core bostonite contains occasional, equant, albite phenocrysts in the trachoidal albite matrix. Such phenocrysts were not seen in surface bostonite samples. The subsurface bostonite intrusion underlying zone 3 is shown in section on figure 7 and its presumed southwestern extension is depicted on figure 8.

The bostonite was extensively brecciated during diatreme activity described in the following section of this chapter. This diatreme activity resulted in the inclusion of bostonite fragments in some heterogeneous breccia types as well as areas of bostonite breccia composed of angular bostonite fragments in a matrix of microcrystalline albite (plate 3c). This matrix likely represents recrystallized comminuted bostonite. Examination of thin sections revealed that some brecciated bostonite has been included in areas mapped as massive bostonite.

The dolomitization characteristic of the bostonite appears to be an early alteration which predated brecciation of the bostonite by diatreme activity. Some outcrops of bostonite are characterized by a close network of coarse crystalline white dolomite veinlets (plate 3a). Fragments of bostonite in adjacent heterolithic breccias on zone 1 commonly contain the same network of dolomite veinlets whereas associated fragments of sandstone are not veined. Perhaps the fracturing and veining of the bostonite in such outcrops was related to the cooling of the intrusive accompanied by autometasomatism. Locally sandstone adjacent bostonite has been dolomitized, notably just north of zone 3.

The mineralogical similarity of the bostonite and the albite syenite dyke, namely a preponderance of albite, paucity of quartz and unusual abundance of apatite, suggests that these intrusions may be genetically related. The textural difference between them suggests that the bostonite was intruded in a hypabyssal environment in contrast to a plutonic environment for the albite syenite. The depth of intrusion of the albite syentite dyke is limited as it postdated the Hornby Channel Formation and predated the dioritic intrusions in the upper Great Slave Supergroup indicating a maximum depth of about 30,000 feet. If the 1872 m.y. Rb-Sr isotopic age of the Seton Formation volcanics determined by Baadsgaard et al. (1973) reflects time of eruption and if the 2170 m.y. and 2200 m.y. K-Ar isotopic ages of the dyke (Baragar, 1963; Burwash and Baadsgaard, 1962) are approximately correct, then the depth of intrusion was less than approximately 10,000 feet. Assuming the bostonite was intruded nearer surface than the dyke, the bostonite must be either older than the dyke or younger than the unconformity at the base of the Et-then Group. Diatreme activity postdated intrusion of both the bostonite and the albite syenite dyke.

Diatremes

A series of complex and highly variable breccia bodies occur along the Simpson Islands fault system. These breccias constitute a system of both isolated and interconnected diatremes which discordantly transect both the Hornby Channel Formation and the underlying Archean basement. In addition to fragments of Hornby Channel Formation and granitic basement rocks, the breccias within the diatremes include fragments and very large allocthonous blocks of apparently unmetamorphosed sediments of uncertain stratigraphic position. Known occurrences of diatreme breccias are scattered along the Simpson Islands fault system over a strike length of 19 miles, 16 miles of which lie within the thesis area and include all but one of the diatreme occurrences known on the Simpson Islands fault system.

Several bodies of similar exotic breccia occur scattered along Inconnu Channel located five miles northwest of the thesis area. These occurrences lie along major faults of the Wilson Island fault system over a strike length of nine miles. Reinhardt (1972) reported occurrences of similar exotic breccias along eight miles of the Preble fault system extending southwest from the southwest corner of the thesis area. Although exotic breccias as described by Reinhardt undoubtedly do occur along the Preble fault system, mapping by the writer indicates that rocks mapped by Reinhardt as exotic breccia of Hornby Channel Formation in the southwest corner of the thesis area are in fact thightly folded strata which probably belong to the Wilson Island Group (map 7). Both the regional and local distribution of bodies of exotic breccia leave little doubt that their emplacement was spatially controlled by major northeast striking faults of the McDonald system.

The diatremes within the thesis area are composed of a complex assemblage

of breccia types as described in detail in chapter 111. Many of these breccias are widely variable and grade into associated breccia types. The most extensive and most complex zone of diatreme activity which occurred on the Simpson Islands fault system appears to have centered on base line 2 between 16+00W and 22+00E (map 8). The only known intrusions of bostonite on the Simpson Islands fault system are intimately associated with the complex system of diatreme breccias within this area. This association indicates a genetic relationship between the bostonite and diatremes even though brecciation postdated cooling of the bostonite.

Within the thesis area, breccia bodies exhibit geometries which include irregular zones, elongate linear zones, well defined narrow dykes which may bifrucate and pipe-like bodies. Within the base line 2 map area two linear geometric trends are evident in the distribution of breccia. The first order or larger scale trend is east-northeast parallel to the Channel fault which appears to have been a primary factor controlling the distribution of breccias along Vestor Channel. The bostonite dyke between zones 2 and 3 parallels this trend. The secondary or smaller scale trend is west-northwest and appears to represent a fracture direction which influenced the form of the intrusive breccia bodies on a more local scale. Many breccia dykes parallel this second order trend.

The diatreme breccias range from breccias composed of fragments of only one rock type to heterolithic breccias composed of several rock types. Fragments are commonly one to several inches across but range up to allocthonous blocks several hundred feet across. Fragments are composed principally of sandstone from the Hornby Channel Formation, siltstone and dolomite from a formation of uncertain stratigraphic position, granitic basement rocks, bostonite, and sediments from a sequence which includes brown shale, hematitic micaceous fine sandstone and hematitic pelletoid

chert of uncertain stratigraphic position.

The various breccias, can be divided into four classes (stages) reflecting different degrees of intensity of brecciation and transport and mixing of clasts. Sandstone adjacent to the diatreme bodies has usually undergone in situ brecciation and is described as stage 1 brecciated sandstone. This brecciated sandstone is characterized by irregular angular networks of fractures and narrow breccia seams with a spacing of a few inches to several feet (plate 2, a and b). Adjacent fragments fit together with only minor relative disorientation and no evidence of significant relative displacement. Fractures are filled with albitized, comminuted, quartzo-feldspathic rock material (plate 5a), secondary quartz or secondary dolomite. The zones of stage 1 breccia adjacent diatremes range from less than a foot wide to areas a few hundred feet across. Some of the more extensive areas of stage 1 breccia in the base line 2 area are possibly underlain by other breccia types.

Rocks described as stage 2 breccia have been shattered into distinct angular fragments generally less than several feet across (plate 2c). The matrix generally comprises 10% to 30% of the rock and is composed of albitized and locally carbonated comminuted quartzo-feldspathic rock material with secondary quartz cement only locally important. Stage 2 breccias are characteristically composed of fragments of only one rock type. Stage 2 sandstone breccias are most abundant but stage 2 breccias of bostonite, siltstone and dolomite are also present. Lack of fit, disorientation of bedding and variations in appearence of adjacent fragments indicate some differential transport and mixing of fragments but uniformity of fragment rock type indicates that mixing of clasts was limited and transport of clasts was probably local. A gradational transition zone of stage 1 brecciated sandstone always separates massive sandstone from stage 2 sandstone breccia.

Stage 2 breccias commonly grade into adjacent stage 3 breccias.

Stage 3 breccias are heterolithic and exhibit a wide range of textures but most are angular and poorly sorted to unsorted (plate 2; d, e, f, g, h). Locally fragments may show evidence of rounding. Fragments vary from microscopic to distinct blocks 200 feet across. Larger blocks up to several hundred feet across are present within areas of stage 3 breccia or margined by narrow zones of stage 3 breccia. The stage 3 breccias have been divided into two types based on apparent matrix composition. In siltstone-rich stage 3 breccias much of the dark grey to black siltstone appears as apparent matrix between the more competant and lighter colored rock fragments. Close examination indicates that much and probably most of this apparent matrix is actually composed of fragments of siltstone which have been compacted together and deformed so as to loose their distinctiveness as fragments. Refer to map unit R, base line 2 for a more detailed description of stage 3 breccia with apparent siltstone matrix.

The second variety of stage 3 breccia is much more siltstone-poor and contains a significant amount of altered comminuted, quartzo-feldspathic rock material as matrix in addition to some apparent matrix siltstone. The comminuted matrix has been extensively recrystallized, albitized and dolomitzed. These alterations are minor or absent in the more impermeable siltstone matrix breccias. The stage 3 breccias with comminuted matrix are described in detail as map unit S, base line 2. Of the two types of stage 3 breccias, granitic basement fragments have been found only in those with appreciable comminuted quartzo-feldspathic matrix, a relationship which suggests that some of this matrix may be derived from comminuted basement rocks. The breccia pipe which occurs north of Cliffed Straits (map 16) is an example of such a stage 3 breccia which contains up to 80%

granitic clasts mixed with sandstone fragments. In the base line 2 area granitic fragments in stage 3 breccias are rare but such fragments large enough to be represented individually on map 8 were found at 9+00W, 2+70S and 29+50W, 6+00S.

Stage 4 breccias are fine breccias of restricted extent in which altered, comminuted rock matrix predominates. Fragments are commonly rounded to subrounded and are heterolithic. Two varieties of stage 4 breccias have been mapped. The first has been termed "breccia dykes with albitized comminuted matrix predominant." This rock is composed of 20 to 70% fragments of quartz, feldspar, sandstone, and granitic rock with local occurrences of siltstone and dolomite fragments. The very finely comminuted matrix (plate 5b) has been extensively recrystallized and albitized and somewhat dolomitized and sericitized. It is usually massive and commonly exhibits a micro-porphyroblastic texture (plate 5; d to h). Locally preferred orientation of elongate grains defines a flow structure (plate 5c). Megascopic clasts range up to a few inches across and are subrounded to rounded. This rock type is described in detail as map unit O, base line 2. This breccia in the base line 2 map area occurs as dykes up to a few feet thick which may bifrucate and which are characterized by sharp contacts. Many of these dykes were too limited to map but the most prominant are represented in the areas of 4+00E, 6+80N and 2+00E-0+80N. This breccia in the base line 1 map area (map 10) occurs as a 200 foot diameter pipe at 29+00E, 7+00S and as three very small bodies 2 to 5 feet across which lie between 35+00E, 5+50N and 42+00E, 4+50N. All four of these occurrences lie on or adjacent to a major fault of the Simpson Islands system.

The second variety of stage 4 breccia has been termed "dolomitized, banded microbreccia." It is a very finely banded breccia composed of 20

to 50% angular to subrounded fragments less than 1 cm across. The fragments comprise sandstone, siltstone, dolomite, bostonite, quartz and feldspar. The finely comminuted matrix has been extensively recrystallized, albitized and dolomitized. This rock type is described in detail as map unit T, base line 2. It occurs as narrow dykes transecting sandstone (plate 3d) and as bands which commonly line the irregular contacts between sandstone and breccia "pipes" filled with dolomitized, albitized stage 3 breccia with siltstone and comminuted matrix (plate 3; g, h). The dykes and marginal bands of this rock type range from a few inches to a few feet thick. Where dykes exceed a few feet in thickness the breccia in the center is massive, coarser and is mapped as a stage 3 breccia with comminuted matrix. Banding in the banded microbreccia parallels contacts with all their irregularities (plate 3; e, f). The banding is continuous over distances of up to several feet and is defined by variations in fragment size, fragment composition, degree of recrystallization and degree of dolomitization (plate 6g).

Mapped relationships around the breccia "pipe" centered at 10+00W, 2+00S on base line 2, suggest that the intrusion of banded microbreccia dykes represented an initial stage in the separation of large blocks of wall rock into a "pipe" of stage 3 breccia with comminuted matrix. At the north end of this "pipe" a 100 x 25 foot block of sandstone adjacent the breccia "pipe" has been isolated from the surrounding sandstone by a banded microbreccia dyke. This dyke is continuous with a layer of banded microbreccia which lines the wall of the breccia "pipe". If this large block had been removed from place and engulfed in the breccia "pipe" this isolating dyke would have become a layer of banded microbreccia lining the margin of the "pipe". The banded microbreccia dyke which parallels the west side of the same breccia "pipe" is separated from the transported and mixed stage 3 breccia within the "pipe" by 10 to 50 feet

of in situ brecciated sandstone (stage 1). The brecciation of the sandstone in this zone appears to have been an initial step in the process of expansion of the "pipe". If this sandstone had been further brecciated and plucked away as fragments in the "pipe" the banded microbreccia dyke would have become a marginal phase of the stage 3 breccia "pipe".

Occasional fragments of banded microbreccia occur within stage 3 breccias with comminuted and siltstone matrix, a fact which attests to the early timing of these dykes in the progressive development of the breccia pipes. The unusual banded structure is most likely a flow feature generated by intrusion of the microbreccia.

Source of Non-Hornby Channel Formation Sedimentary Rocks in Diatremes

In addition to Hornby Channel Formation sandstone, the diatremes in the base line 2 area contain fragments and large blocks from a sequence of grey to black siltstone with interbedded dolomite and a sequence of brown shale, red micaceous fine sandstone and siltstone and red pelletoid chert. Where these rocks are found as components of stage 3 breccias they are intrusive and all contacts are brecciated, discordant and highly irregular. Southwest of 15+00W, base line 2, several large outcrops of undeformed, but steeply dipping (locally overturned) grey siltstone and dolomite are found. In these areas the undeformed siltstone and dolomite is nowhere in sedimentary contact with Hornby Channel Formation sandstones. The contacts are everywhere marked by zones of breccia and where linear, mylonite is commonly found along the edge of the sandstone outcrop. Bedding orientation is uniform within each exposure of the siltstone-dolomite sequence but varies between individual exposures which are separated by zones of breccia. These exposures are considered large, disoriented,

allochthonous blocks which are commonly tabular parallel bedding and which range up to at least 250 x 800 feet in size. It appears that faulting, some of which postdated diatreme activity, played a role in producing the present distribution of siltstone and dolomite along Vestor Channel southwest of 15+00W, base line 2.

Map 7 shows the location of a small island at the southwest end of Vestor Channel which is underlain by near vertically dipping dark grey siltstone with rare thin dolomite lenses comprising a stratigraphic thickness of 400 feet. This outcrop plus two other outcrops of siltstone and dolomite along Vestor Channel, which are sufficiently dissimilar to preclude stratigraphic repetition, indicate the total stratigraphic thickness of the succession must exceed 700 feet. A large block of bedded brown shale, red micaceous fine sandstone and siltstone and pelletoid chert represents a stratigraphic thickness of approximately 100 feet. In view of its lithological distinctiveness and substantial stratigraphic thickness, the grey siltstone-dolomite succession must belong to a formation other than the Hornby Channel Formation.

Did the siltstone-dolomite sequence underlie the Hornby Channel Formation? As previously discussed several exposures of the sub-Hornby Channel unconformity have been mapped along the Simpson Islands fault system. In all cases Hornby Channel Formation sandstone directly overlies Archean basement. This relationship was encountered in a drill hole on zone 7 only 200 feet from a major outcrop of siltstone-dolomite breccia. Although the unconformity across South Simpson Island is not exposed the overburden covered zone commonly obscures only a thin stratigraphic interval, as little as 10 to 20 feet, thus precluding the existance of a significant unit of siltstone and dolomite below the basal orthoquartzite of the Hornby Channel Formation on South Simpson Island.

If the siltstone-dolomite sequence underlay the Hornby Channel Formation it must have been preserved as a near vertically walled, fault bounded slice of sediment more than 700 feet thick and as little as 1000 feet or less wide which was separated from the Hornby Channel Formation by an unconformity. Features observed along the Simpson Islands fault system north of Union Island suggest that the Union Island Group was preserved in down dropped fault slices. However, where the Hornby Channel Formation overlies Union Island Group on Union Island, the basal Hornby Channel sandstones contain clasts of dolomite from the underlying Union Island Group. The Hornby Channel Formation in the thesis area does not contain siltstone and dolomite clasts similar to those within the diatremes. Instead, granitic debris is common. The rare stromatolitic dolomite fragments found in one breccia exposure (plate 1; e,f) are not from the Union Island Group if, as Hoffman (1968) claims, stomatolites did not exist during deposition of the Union Island Group. These considerations suggest that the siltstone and dolomite within the diatremes may have been derived from above the Hornby Channel Formation.

The most likely overlying source for the siltstone and dolomite is the Duhamel Formation which directly overlay the Hornby Channel Formation. Unfortunately exposures of Duhamel Formation are unknown in the southwestern half of the East Arm with the possible exception of a sequence of interbedded dolomite and quartzite exposed on Jackson Island 19 miles west-northwest of the thesis area (Hoffman 1968). Hoffman has described the Duhamel Formation in the type section 75 miles northeast of the thesis area as stromatolitic dolomite with some sandstone interbeds and ripple-laminated brown or green siltstone. Derivation of the siltstone and dolomite from above the Hornby Channel Formation is consistent with Reynolds (1954) observation that very large blocks in a diatreme can

be expected to subside, even through upwardly mobile finer material, due to insufficient support in a fluidized system. This argument is, however, not compelling as very large blocks which were transported upward for great distances have been reported in some diatremes (Snyder and Gerdmann, 1965).

In conclusion one is forced to regard the non-Hornby Channel Formation sedimentary rocks within the Simpson Islands diatremes as derived from a formation of uncertain stratigraphic position.

Diatreme Formation

The Simpson Islands breccias appear to have been produced by the forcible escape of a hydrous gas or a very mobile fluid phase from below and perhaps within the Hornby Channel Formation. The formation of the breccias involved extensive comminution of rock material which in part formed matrix for transported fragments and was in part injected into network fractures surrounding breccia "pipes". As described in detail by Reynolds (1954), fluidization processes were likely involved in the generation of comminuted quartzo-feldspathic material and its injection into the network fractures of stage 1 and 2 brecciated sandstone as well as the injection of stage 4 breccia dykes. Heterogeneity of breccias, occurrences of flow structure in some comminuted material, banding in some breccia dykes and rounding of clasts in stage 4 breccias and very locally in some stage 3 breccias all provide further evidence that fluidization played an important role in the formation of the diatreme system (Lorens, McBirney and Williams, 197?). The extensive fracturing and fragmentation of rocks in and around the breccia bodies may have been the result of either an initial explosion or hydraulic fracturing (Shoemaker et al., 1962).

Perhaps both processes contributed to brecciation. The drusy vein quartz and dolomite which fills some fractures in stage 1 breccias provides direct evidence that not all fracturing was produced by hydraulic injection of fluidized comminuted rock.

The escaping hydrous phase extensively altered those breccias with a significant, comminuted quartzo-feldspathic matrix. Alteration consisted principally of strong albitization, weak to strong dolomitization and weak sericitization and hematization. Alteration preferentially affected the comminuted matrix but also affected phenoclasts of different rock types to different degrees. The altered comminuted material was variably recrystallized as evidenced by patches of more coarsely crystalline albite mosaic (plate 6; a, b) and porphyroblasts of carbonate, quartz, muscovite and albite (plate 6; d to h). Carbonate porphyroblasts which always appear paragenetically latest, are euhedral and commonly zoned (plate 6f). Hematite occurs principally as an extremely fine dusting which invariably has colored all albite brick red to pink. Minor specular hematite occurs as very thin veinlets in breccias and siltstone. Alteration is of relatively minor significance in breccias with a very siltstone rich matrix. A little secondary albite does occur in such rocks as thin pink veinlets which are not magmatic. The extensive alteration of breccias with significant comminuted quartzo-feldspathic matrix was likely promoted by the highly chemically reactive conditions between gas and solid phases in a fluidized system as discussed by Reynolds (1954).

Intrusion of magma was not a direct agent of brecciation. Most likely the occurrence of bostonite exclusively in association with diatreme breccias is no coincidence but the nature of any genetic connection is not so clear. As previously discussed bostonite is found only in the base line 1 area as several small bodies scattered over an area of approximately

4000 feet by 2000 feet coincident with the most heterogeneous and complex breccias of the diatreme system. The bostonite has been extensively brecciated by diatreme activity and likely all the exposures are projections from a single underlying intrusion which was disrupted by the diatremes. Nowhere was bostonite seen which intruded breccias but large blocks of bostonite and areas of brecciated bostonite occur within diatremes.

These features indicate that the bostonite represents an irregular hypabyssal intrusion exposed very near its top. The trachoidal texture indicates it was largely crystalline at the time of emplacement. The bostonite cooled, fractured and was extensively dolomitized, partly as veins, prior to diatreme activity. Alteration of the bostonite was probably autometasomatic as such alteration is a general characteristic of bostonite.

It is tempting to speculate that diatreme activity was the result of violent degassing of underlying volatile rich bostonite magma with the hydrothermal phase becoming a carrier of albite and carbonate into the diatreme system where it produced widespread metasomatism. Such violent degassing could have been the result of sudden decompression of the magma induced by hydraulic fracturing to surface (Shoemaker et al. 1962). Because the bostonite intruded the Simpson Islands fault system, such decompression also could have resulted from brittle failure and seismic strain release on the fault triggered by magma intrusion. This hypothesis requires that the presently exposed bostonite was intruded and cooled before continued or recurrent upwelling of magma farther below induced fault movement. This is consistant with our knowledge that the base of the diatremes lies somewhere below the top of the bostonite.

As an alternative hypothesis, diatreme activity could have been triggered by thermal expansion of ground water due to bostonite intrusion

(Johnston and Lowell, 1961). Rising magma would be expected to encounter a more water rich environment upon intrusion to the level of Proterozoic sediments, in particular the Hornby Channel Formation sandstones which may have been considerably more porous at the time. Reinhardt (1972) favours the thermal expansion hypothesis for generation of the Simpson Islands breccias. This hypothesis is weakened by the evidence that the diatremes extend into the basement an unknown distance below the unconformity. Diatremes filled principally with fragments of Archean basement occur north of Cliffed Straits (map 16) as described in chapter 111 and three miles southwest of the west end of Vestor Channel as described by Reinhardt (1972). The latter occurrence is approximately three miles southwest of the nearest proterozoic sediments which are Hornby Channel Formation. Assuming the unconformity dips a modest 10° northeast it is possible that this diatreme is exposed at an erosional level approximately 2700 feet below the unconformity. The presence of fragments of granitic rock in the base line 2 diatremes confirms that they too extend into the basement.

The development of abnormally high water pressure,(geopressure) within rocks along the Simpson Islands fault system may have contributed to, or triggered, diatreme activity. Conditions favorable to the development of geopressured zones would have been attained if the sequence of siltstone and dolomite involved in the diatremes was preserved in a narrow fault-bounded slice below the Hornby Channel Formation. Geopressured zones develop in subsiding sedimentary basins due to restricted fluid movement in strata which are rapidly buried (Jones, 1969). Geopressured zones can occur at depths as little as 5000 feet and are characterized by abnormally high temperatures, commonly in excess of 260°C (Dorfman and

Kehle, 1974). Geopressured zones are thermal insulators and are characterized by abnormally steep thermal gradients (Lewis and Rose, 1969). Development of geopressure in a narrow fault block of bedded siltstone and dolomite beneath the Hornby Channel Formation could have been promoted both by rapid burial and by liberation of water from clay minerals due to diagenesis and metamorphism (Jones, 1969). Expulsion of water into fractures could have generated a geopressured zone which extended down into a hydro-system in the crystalline basement rocks along the Simpson Islands fault system beneath the fault slice of siltstone and dolomite.

Geopressure alone could have produced hydraulic fracturing or have induced fault movement which would have resulted in decompression of the zone. Bostonitic magma intruded into or below the geopressured zone would have produced a high local heat gradient enhanced by the insulating effects of the zone. Heat contributed through a period of time by cooling of the already crystalline bostonite (largely crystalline at the time of intrusion) would have further elevated the temperature of the geopressured zone and pressure would have increased due to metamorphic liberation of water and possibly due to addition of magmatic fluids. Hydraulic fracturing up to surface or permeable overlying strata or fault movement could have resulted in explosive decompression of the hydrothermal system. Explosive brecciation could have extended down into the geopressured basement as the diatremes propagated downward with the decompression front.

An instructive comparison can be made between the Simpson Islands diatremes and a series of diatremes located along an Illinois-Missouri-Kansas axis described by Snyder and Gerdemann (1965). There eight explosive

features are aligned along a 400 mile east-west trending structural zone which likely reflects a major fault in the Precambrian basement. Explosive gas activity and related magmatism spanned a period from Upper Cambrian to early Tertiary time. Diatremes originated in the basement and blocks were transported as much as 8000 feet up and 3000 feet down with extensive mixing of fragments from both higher and lower in the stratigraphic column. Megabreccias, extensively fractured wall rocks and associated breccia dykes are described.

Alteration of Hornby Channel Formation Sandstones

Within the thesis area there appears to be a pronounced increase in the degree of induration of Hornby Channel Formation sandstones within a couple of thousand feet of major northeast striking faults. The sandstone along the Simpson Islands fault system and the Preble fault are more erosionally resistant and form broad northeast trending ridges. The sandstone along these ridges appears much more massive with respect to bedding planes both on air photographs and in the field. Quartz and quartz-albite veins and veinlets are abundant near faults on both the north and south sides of the thesis area but are virtually absent away from faults in the center of the thesis area south of the Simpson Islands fault and north of Preble Channel. On a very local scale, such as areas within the zone 5 geology map area (map 13), the sandstone is much more siliceous, impermeable and indurated within areas with a high density of quartz and quartz-albite veins. These veins commonly have gradational contacts with adjacent sandstone.

The most prominent quartz vein set has an east-southeast strike and a steep dip consistent with the shear orientation conjugate to the east-northeast striking faults during dextral shear. Large quartz veins

commonly occupy faults of the Simpson Islands system. The largest of these is continuous along the plane of the Channel fault for a strike length of at least 9000 feet and in two areas this vein attains a thickness of 100 feet (maps 10 and 15). The sandstone adjacent major faults commonly contains a high density of small quartz veins and stringers.

These features indicate the Hornby Channel Formation sandstones have been silicified in proximity to major east-northeast striking faults. Petrographic examination of sandstones has been largely limited to samples from near faults and has revealed abundant evidence of silica remobilization. Quartz overgrowths and contact cement (plate 7g) provide evidence of silica deposition in some samples. Contact solution (plate 7f) and stylolites (plate 7h) provide evidence of silica removal in other samples. It is probable that silica redistribution in fault proximal sandstones was promoted by fault related folding and hydrothermal activity.

Examination of thin sections stained for both potassium feldspar and plagioclase has revealed the presence of widespread albitization in sandstones along the Simpson Islands fault system and the Preble fault. The secondary albite invariably contains an extremely fine dusting of hematite which has colored the feldspar pink to reddish pink. Most commonly albite has partially or completely replaced detrital potassium feldspar (plate 7; a, b). In strongly altered samples the albite also forms a secondary cement which has locally replaced some detrital quartz (plate 7; c, d). On a megascopic scale, moderate albitization is manifested by pinker detrital feldspar grains and strong albitization produces a general reddening of the outcrop.

The actual distribution of albitized sandstones cannot be evaluated without more extensive petrography but the available data suggests that

albitization is especially widespread in and around diatremes, in the base line 1 area east of 44+00E and close to the Preble fault on Ped Peninsula. In some areas, for example immediately northeast of Romeo Lake (map 15), sandstone appears albitized adjacent major faults. Albitization within diatremes has already been described. In addition to albitization related to diatreme activity it seems quite likely that albitization was also produced by hydrothermal activity along faults. Albitization in the area of the east end of base line 1 may have been the result of hydrothermal alteration above the albite syenite dyke which was intruded a short distance below these outcrops.

Conclusions

The Simpson Islands fault system within the thesis area has been the locus of albite syenite intrusion, bostonite intrusion, diatreme activity and widespread silicification and albitization. These geological events are all genetically related to the controlling Simpson Islands fault system. Although the exact nature of temporal and genetic relationships among these events has not been established, it seems likely that such a genetic relationship exists.

An albite syenite dyke of plutonic aspect was intruded along faults of the Simpson Islands system and reached its upper level of intrusion in the thesis area. It was intruded after deposition of the Hornby Channel Formation and represents the upper end of a 16 mile long differentiated dyke of possible alkaline affinity. It was offset by late movements of its controlling faults.

An hypabyssal bostonite stock of complex geometry was intruded into the Hornby Channel Formation within the Simpson Islands fault zone close to the petrologically similar albite syenite dyke. It too reached its upper level of intrusion at the present erosion surface. The bostonite

was associated with strong autometasomatic alteration, principally dolomitization, and may have produced albitization of adjacent sandstone. The timing of bostonite intrusion relative to intrusion of the albite-syenite is not known.

Violent gas escape from a source within the Archean basement produced a complex system of irregular diatreme "pipes" and associated breccia dykes. Breccias are highly variable in composition but all are composed of fragments of pre-existing rock. Comminuted rock material is a common breccia matrix and has been extensively albitized and carbonated. Diatreme development produced extensive fracturing of sandstone wall rocks and probably involved fluidization processes and explosive activity. In addition to fragments of Hornby Channel Formation sandstone, granitic basement and bostonite, the diatremes contain fragments and very large blocks from at least one sedimentary formation of uncertain stratigraphic position.

Sandstone along the Simpson Islands fault system was extensively silicified and albitized. Silicification is manifested by stronger cementing of sand grains and by quartz veining. Albitization is manifested by replacement of detrital potassium feldspar grains and in extreme instances by secondary albite cement. Albite also occurs in veins with quartz. Silicification appears related to the fault system whereas albitization appears related to both diatremes and faults as well as possibly to intrusions.

CHAPTER VI

URANIUM MINERALIZATION

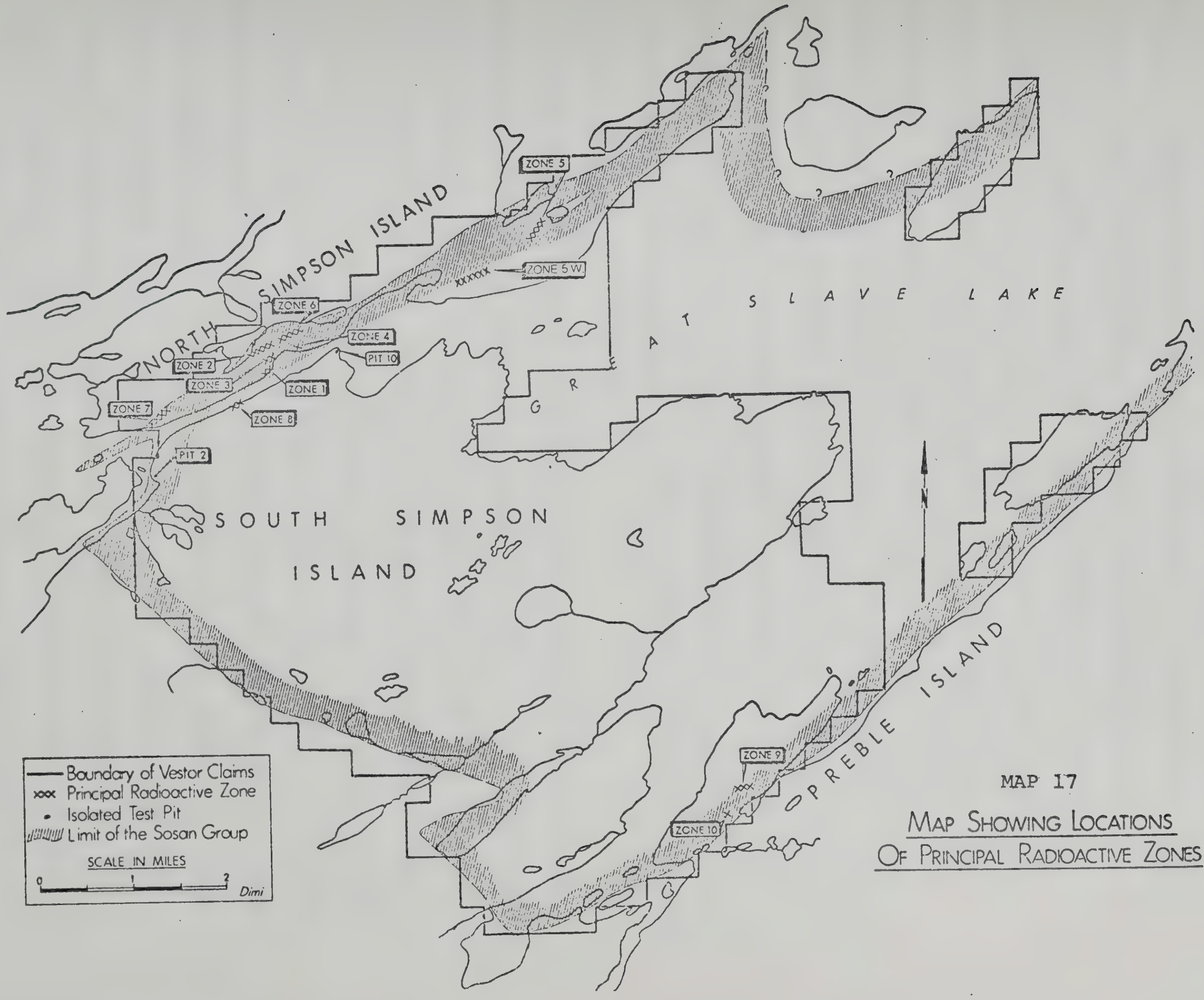
Introduction

Numerous uranium deposits of several different types occur scattered throughout the East Arm of Great Slave Lake. To date none of these have been mined. These occurrences include fault-controlled uraninite veins in mylonitic rocks, uraninite-bearing veins (some with cobalt-nickel arsenides) which cut granodioritic stocks and their wall rocks, and an unusual monazite-rich occurrence in Duhamel Formation dolomite. Some of these deposits have been described by Lang (1952), Lang et al. (1962) and Barnes (1952). In 1970 Vestor Explorations Limited undertook an extended prospecting program focussed on arenaceous rocks of the Sosan Group which revealed the presence of many uranium occurrences within these strata throughout the East Arm. The Company has conducted detailed evaluations, including diamond drilling, on several of these occurrences in sandstones of the Hornby Channel and Kluziai Formations. Despite the current lack of any uranium producers, the many occurrences qualify the East Arm as a uraniferous metallogenic province.

Although the Simpson Islands uranium deposits occur in a more complex geological environment, in many ways they are similar to other occurrences in the Sosan Group, particularly those near Snowdrift and Reliance.

Radioactivity in the Simpson Islands Area

Prospecting conducted in 1969 and 1970 in the Simpson Islands area located 11 radioactive zones and approximately 120 isolated radiometric anomalies due to localized uranium enrichment in Hornby Channel Formation sandstones. The locations of the radioactive zones are shown on map 17, and the isolated anomalies are shown on map 7. In addition to these



MAP 17

Map Showing Locations Of Principal Radioactive Zones

uranium occurrences, a few hundred radiometric anomalies were located which were produced by thorium in zircon rich hematite laminae These heavy mineral bands, composed principally of hematized detrital magnetite (described in chapter IV), are of no economic significance.

The most significant zones of uranium mineralization lie within the base line 1 and base line 2 map areas and their locations with respect to the geology are shwon on maps 8 and 10. Maps 9 and 11 are radiometric contour maps of the two base line areas. The zones of uranium mineralization within the two base line areas were mapped radiometrically and topographically at 1 inch equals 40 feet based on alidade survey control. The most detailed survey was conduted over zone 5, the most encouraging zone. The detailed radiometric contour map of only zone 5 is included as an example (map 14). Map 13 provides the detailed geology of zone 5 for comparative purposes.

Comparison of radiometric maps with geology maps shows that certain rock types in the base line 1 area, not included within uranium mineralized zones, are characterized by unusually high background radioactivity. These rock types are generally fine grained, hematitic, micaceous sandstones and fine to medium grained, pink, feldspathic sandstones. Similar rock types elsewhere in the Simpson Islands area are also characterized by high background radioactivity. The high background of these rock types is probably due to greater primary potassium and thorium contents. Extensive radiometric and chemical assays of samples from bedrock pits and drill core indicate that the anomalous radioactivity within the defined zones is due to enrichment in uranium with generally negligable amounts of the thorium. Map 18 illustrates surface assay values obtained from zone 5 for comparison to the detailed radiometric contour map of zone 5 (map 14).

There is no consistent geometric or spatial relationship between

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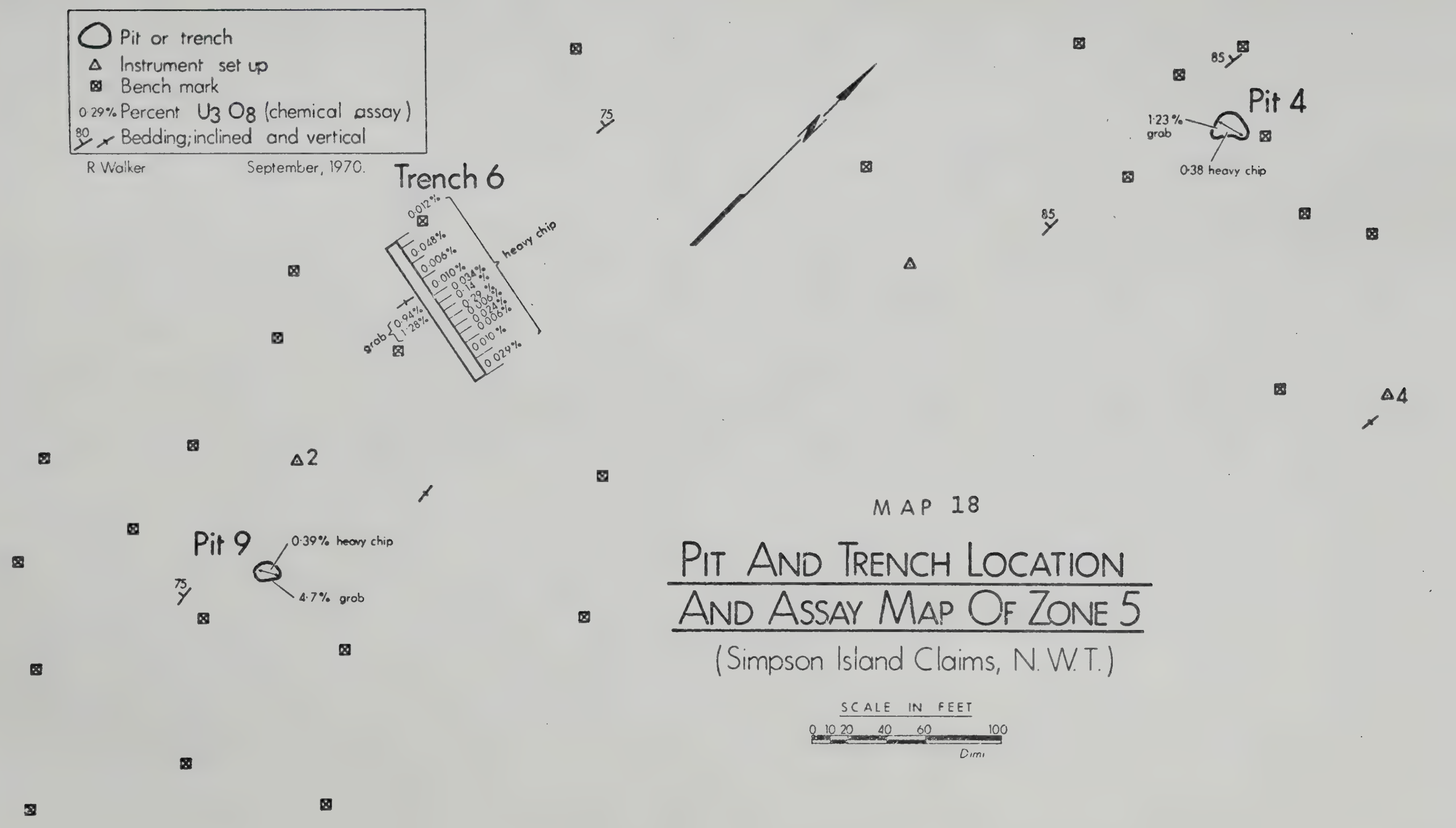


MAP 18

Pit And Trench Location And Assay Map Of Zone 5

(Simpson Island Claims, N.W.T.)

radioactive zones and either diatremes or faults. Uranium enriched radioactive zones occur in various stratigraphic units right from the basal orthoquartzite (zone 7) through to one of the highest stratigraphic levels exposed within the two base line areas approximately 1400 feet above the basement (zone 5 west). Most radioactive zones exhibit a general trend which is conformable to bedding in the host sandstone. Smaller scale trends are apparent within some radioactive zones and appear to be controlled by local features such as joints and topography. Zone 5 is the best example.

Examination of the zone 5 radiometric map (map 14) reveals two radiometric trends. The first is a very gross parallelism of the zone with bedding. The second is an alignment of radiometric highs in an east-southeast direction. Figure 14 is a stereographic projection of joint and quartz vein attitudes taken across zone 5. There are two very diffuse joint sets and one quartz vein set with slightly less scatter. The quartz veins, like one set of joints, strike east-southeast to southeast but dip less steeply than the joints. It is probable that one of the two is related to the smaller scale radiometric trend. It would be more reasonable to correlate the southeast striking joint set with the radiometric trend for two reasons. First, individual quartz veins and strongly veined areas on zone 5 are not unusually radioactive. Secondly, almost all the radioactivity measured in the scintillometer survey derived from secondary uranium minerals very near the surface and enrichments of secondary uranium minerals commonly coat joints. Either primary epigenetic mineralization or the redistribution of uranium as secondary minerals would have been influenced by permeable joints. In places on zone 5, radiometric highs show a good correlation with topographic lows. This may be due to topographic lows acting to channel present surface runoff and hence control

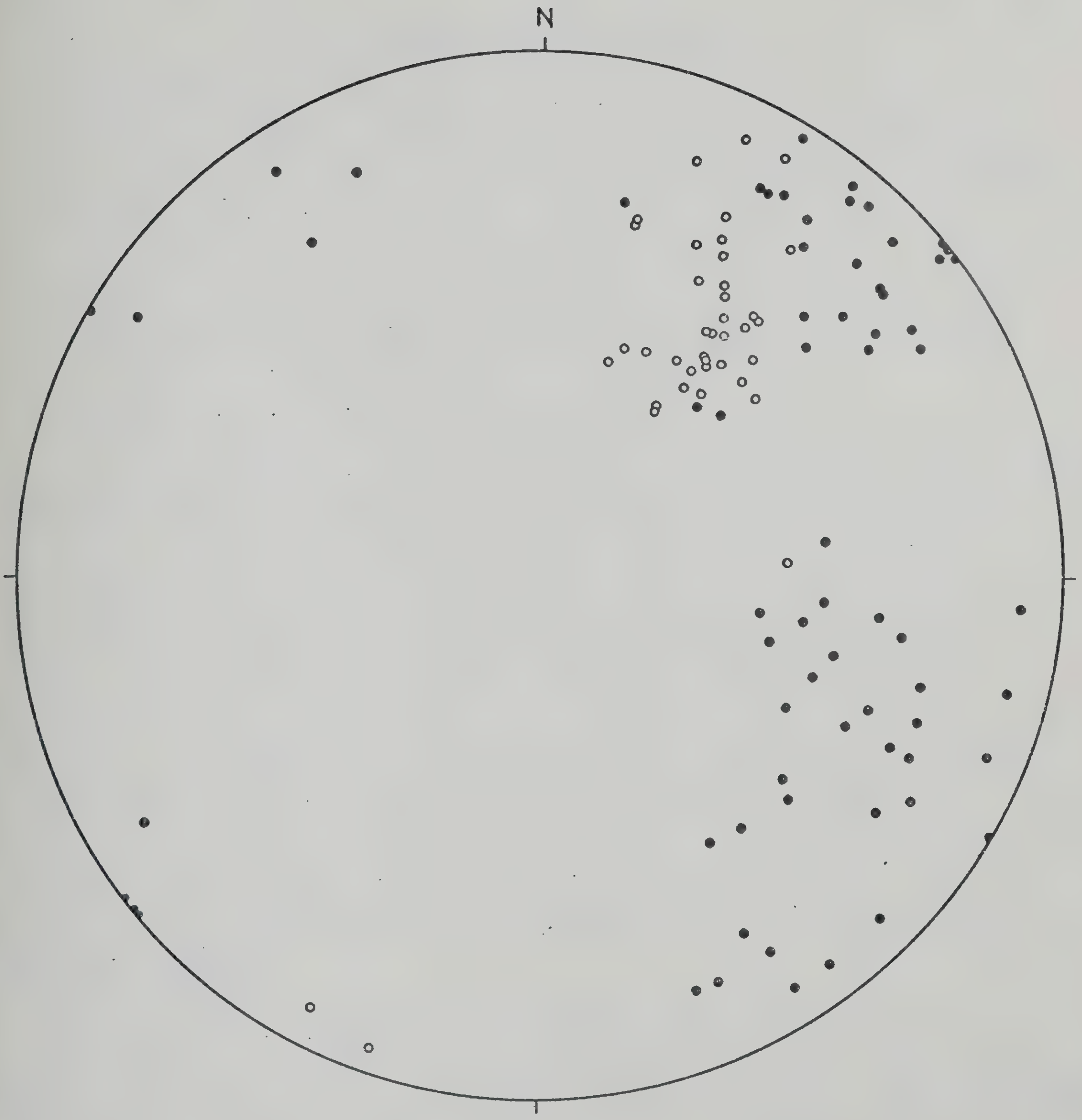


Figure 14. Stereographic projection of poles to joints and quartz veins from zone 5. Solid circles are poles to joints, open circles are poles to quartz veins.

ongoing surficial redistribution of secondary uranium minerals.

Oxidized Uranium Mineralization

Uranium mineralization within Hornby Channel Formation sandstones in the thesis area can be divided into two types referred to as oxidized and reduced uranium mineralization. Oxidized mineralization is characterized by an absence of pyrite and contains secondary uranium minerals in which uranium is hexavalent. Reduced mineralization is pyritic, and contains uranium minerals in which uranium is tetravalent.

The most widespread uranium mineralization in the Simpson Islands area comprises secondary uranyl compounds which occur as joint and fracture coatings, grain coatings and disseminated interstitial grains in the host sandstone. In several occurrences the weathered outcrop surface shows a patchy stain of these yellow, green and rarely orange uranium minerals. Most commonly surface uranium stain is absent and secondary uranium minerals can only be seen after blasting of the radioactive outcrop. The majority of these occurrences are due primarily to fracture coatings which commonly are concentrated within several inches of the weathered surface.

The secondary uranium minerals which have been identified by x-ray powder diffraction analyses are: soddyite ($5UO_3.SiO_2.6H_2O$), cuprosklodowskite ($CuO.2UO_3.2SiO_2.6H_2O$), liebigite ($Ca_2(UO_2)(CO_3)_3.10H_2O$) and becquerelite ($7UO_3.11H_2O$?). Other minerals indicated but not confidently identified are billietite ($BaO.6UO_3.11H_2O$) and vandenriesscheite ($PbO.7UO_3.12H_2O$). In addition to these, Morton (1974) has reported uranophane ($CaU_2O_3Si_2O_8.7H_2O$) and compreignacite ($K_2O.6UO_3.11H_2O$). In very rare occurrences erythrite ($CO_3(AsO_4)_2.8H_2O$) coats fractures in association with secondary uranyl minerals. Oxidized uranium mineralization usually but not always,

occurs within or closely associated with localized hematite staining which has permiated the sericitic matrix of the host sandstone to produce a medium to dark red coloration of the rock. The hematite stained areas are patchy in shape, up to several tens of feet across and in many cases the long axes of hematized patches are oriented parallel strike. Localized hematite staining is commonly not associated with radioactivity. Association of radioactivity with hematite staining is strong on zones 1 and 5 but only moderate to weak on other zones. A few radioactive bedrock pits are devoid of hematite staining. Goethite staining is only common on zone 1 where it produces small rusty patches on the outcrop surface above non-radioactive pyritic sandstone. Elsehwere in the Simpson Islands area, geothite characteristically stains sandstone surrounding occasional pyrite occurrences which are not associated with radioactivity.

The oxidized uranium mineralization is of little economic potential, being characteristically low grade. Chemical assay grades greater than 0.1% U_3O_8 are uncommon and are usually restricted to grab samples containing very localized fracture coatings or enrichments of secondary uranium minerals from very near the weathered surface. It appears unlikely that a substantial volume of rock characterized by oxidized mineralization would grade more than a few hundredths of a percent U_3O_8. Th/U ratios of oxidized mineralization in hematite stained sandstone ranged from 0.13 to 0.5. The Th/U ratio of oxidized mineralization in unstained buff to pale green sandstone was approximately 0.12 (Morton, 1974). Assay data indicates that oxidized mineralization contains erratically variable silver grades which range from nil to 3.64 oz. Ag/T but which generally do not exceed a few tenths of an ounce. Assays indicate gold content is usually nil to trace and rarely up to a few hundredths of an ounce per ton.

All zones except 7 and 5 owe their radioactivity to oxidized mineralization. It is significant that diamond drilling of zones 2, 3, 6 and 5 west indicated that the oxidized mineralization is limited almost entirely to the sandstone very near surface. Only on zone 1 did diamond drilling encounter significant oxidized mineralization not associated with reduced uranium away from surface.

Reduced Uranium Mineralization

The most economically significant type of mineralization present in the Simpson Islands area comprises grey to black, pyritic sandstone in which tetravalent uranium occurs in uraninite and coffinite. Chalcopyrite, and galena are commonly present in minor amounts and trace cobaltite, arsenopyrite, covellite, hematite, sphalerite and anatase are present locally. These minerals are characteristically very fine grained and occur interstially in the host sandstone which shows textural evidence of replacement of silicates (plate 7e). Uncommonly uranium and sulphide minerals occur as very thin, usually microscopic, veinlets and in fractures transecting quartz pebbles (plate 8). Minor carbonate is the only associated gangue mineral.

Uraninite typically occurs as anhedral grains and interstitial networks which have been replaced to varying degrees by coffinite (plate 9; a, b, e, f). The uraninite is inhomogeneous with respect to reflectance. The measured reflectances of five separate grains ranged from 18.2% to 15.0% (in air at 546 nanometers). The uraninite cell edge dimension was calculated from $d_{(111)}$ measured from x-ray diffractograms in comparison to a quartz internal standard. X-ray diffraction powder photographs produced diffuse lines indicating a range in cell size. This was manifested on diffractograms by a broad skewed $d_{(111)}$ peak with a mode

corresponding to to a=5.47 Å. The skewed curve indicated that the cell size ranges continuously from this value down to 5.39 Å.

Variation in cell size of uraninite is principally the result of three factors: variation in rare earth and thorium content, degree of disorder of interstitial oxygen atoms and degree of oxidation (Brooker and Nuffield, 1952, Berman, 1957 and Frondel, 1958). It is assumed that thorium and rare earth contents did not vary appreciably within individual primary uraninite grains. The range in cell size of the Simpson Islands uraninite is far in excess of the 0.035 Å maximum variation which can be produced by variations in degree of ordering of interstitial oxygen (Berman, 1957). It is therefore concluded that the variation in cell size is the result of variable oxidation of the uraninite with higher UO_3 content producing smaller unit cell size. This is supported by the variation in reflectivity. Progressive oxidation of uraninite produces a decrease in reflectivity as described by Ramdohr (1969) who also noted such oxidation as an intermediate step in the alteration of uraninite to coffinite by weathering processes.

Coffinite is present in the reduced mineralization as an alteration of uraninite. The coffinite typically has replaced uraninite inward from grain margins and the contact between coffinite and uraninite is highly irregular (plate 9; a, b). In places uraninite from a single primary grain has been replaced so as to leave a series of uraninite remnants within secondary coffinite. In some grains replacement has been complete. The measured reflectance of grains petrographically identified as coffinite ranged from 7.2% to 9.2% (in air at 546 nanometers). Ramdohr (1969) has pointed out that coffinite and certain types of oxidized uraninite or pitchblende (e.g. nasturan 111) may be petrographically indistinguishable. The identification of coffinite has been confirmed by non-quantitative

electron microprobe analyses performed by Dr. D. G. W. Smith. These analyses indicated that material with the optical properties of coffinite contains appreciable amounts of silicon. Electron microprobe x-ray photographs presented in plate 10 illustrate the siliceous composition of the coffinite compared to uraninite in samples from both the Simpson Islands and Reliance areas. Despite the demontrated presence of appreciable amounts of coffinitic material in some samples, x-ray diffraction analysis of heavy mineral separates failed to detect even the strongest coffinite reflections. The secondary coffinite is essentially amorphous.

Reduced mineralization characteristically contains minor to a few percent pyrite as euhedral to anhedral grains disseminated interstitially in the host sandstone and as occasional thin films on fractures. Textural evidence indicates two generations of pyrite. Most pyrite predates and is commonly partially replaced by uraninite which was subsequently altered to coffinite (plate 9c). The second generation of pyrite forms thin rims around uraninite-coffinite grains (plate 9; a, b) and in places forms thin overgrowths on first generation pyrite from which it may be partially separated by a thin layer of uraninite-coffinite (plate 9d). The second generation pyrite postdated uraninite but predated coffinite. In places alteration of uraninite to coffinite has been localized along contacts of uraninite with both first and second generation pyrite.

Minor amounts of galena and chalcopyrite are usually present in the reduced mineralization. Some galena occurs as extremely fine grains disseminated in grains of uraninite-coffinite and represents exolved radiogenic lead. Some galena, which may be primary, occurs as isolated grains and composite grains with uraninite and coffinite in which the amount of galena may exceed the amount of uranium minerals. Chalcopyrite appears to be younger than the first generation pyrite and has in turn been replaced

by uraninite. Locally trace covellite occurs as an alteration of chalcopyrite.

Only trace amounts of bladed hematite, subhedral to euhedral arsenopyrite (safflorite ?) (plate 9f) and granular sphalerite occur in reduced mineralization. Morton (1974) has identified cobaltite (pre-uraninite) and anatase.

The grey to black sandstone which contains reduced uranium mineralization generally contains 0.5 to 1.5% U_3O_8 as indicated by extensive chemical assays. Th/U ratios range from 0.05 to 0.07 (Morton, 1974). Silver and gold occur erratically in concentrations up to o.4 oz. Ag/T. and 0.64 oz. Au/T. Limited assay data indicate a maximum of 0.3% Cu and nil cobalt. Partial chemical analysis of four samples from the Simpson Islands area (zone 5) were tabulated by Morton (1974) and are included here as table 5.

Reduced uranium mineralization is only seen after bedrock blasting although in one place it came within an inch of the bedrock surface. Bedrock blasting has revealed irregular patches of reduced mineralization with a maximum dimension of 10 feet. Patches of reduced mineralization are best developed on zone 5 but have also been exposed on zone 7 and at pit 10 (map 17). A very minor amount was encountered by diamond drill holes under zones 1 and 3 where the rare intersections are less than a few inches long. Although drill core intersections of reduced mineralization were all less than 10 feet in length, drill holes on zone 5 have enabled the interpretation of pipe-like mineralized shoots under pits 4 and 9 which plunge southeast at -70° and -40° respectively. Such shoots would be highly discordant to bedding. The mineralized patches exposed on surface similarily show no conformity to bedding.

Reduced uranium mineralization has been leached back from joints so that the grey to black mineralized sandstone is now separated from joint

TABLE 5. PARTIAL CHEMICAL ANALYSES OF REPRESENTATIVE MINERALIZED ARENITES FROM GREAT SLAVE LAKE, N.W.T. From Morton (1974).

Locality	SIMPSON ISLAND				SNOWDRIFT			RELIANCE
Specimen No.	T4	T6	T6-4	T6-5	SP-2N	SP-2W	SP3-N	RP-4
SiO_2 (%)	>90	>90	>90	>90	>90	>90	>90	84.71
Al_2O_3 "	1.98	2.38	4.96	5.54	2.53	3.13	2.48	2.52
$\sum$ FeasFe_2O_3 "	1.19	1.39	0.99	0.40	tr	tr	tr	9.69
MnO "	n.d.	n.d.	n.d.	n.d.	0.01	0.01	0.01	0.02
MgO "	0.25	0.45	0.35	0.10	0.10	0.10	0.10	0.10
CaO "	n.d.	0.40	0.40	tr	tr	tr	tr	0.10
Na_2O "	0.02	0.24	0.26	0.01	0.62	0.02	tr	0.07
K_2O "	0.41	0.67	1.53	1.87	2.24	1.50	1.21	0.67
TiO_2 "	0.08	0.04	n.d.	0.77	0.20	0.22	0.04	0.08
U_3O_8 "	0.54	0.39	0.21	0.01	0.41	0.4	<0.01	1.50
I.L. "	0.96	0.71	0.84	1.02	0.72	0.66	0.76	1.15
Th (ppm)	350	232	26	-	-	-	-	530
Ba "	109	129	114	139	1122	800	1241	163
Sr "	59	79	55	54	40	50	40	10
Co "	135	133	127	168	179	124	174	217
Cr "	55	65	42	61	42	28	10	<10
Cu "	89	10	30	10	30	10	337	30
Ni "	22	40	34	10	40	10	10	64
V "	49	69	69	20	20	10	10	35

[a] U, Th determination by gamma spectrometry, Univ. of Alberta; all other elements by arc spectrography – K. Govindaraju, C.R.P.G., Nancy). I.L. = loss on ignition.

planes by zones of unmineralized buff sandstone a fraction of an inch to a few inches wide. Thus some larger patches of reduced mineralization have been subdivided into smaller joint controlled patches separated by narrow leached bands. These leached bands are neither hematite nor limonite stained and the grey to black pyritic sandstone contacts directly with buff leached sandstone.

In contrast to the general case wherein reduced uranium mineralization has been leached back from joints and the weathered surface, a few examples have been found of very sooty black, very uraniferous mineralized sandstone localized as a thin layer within a fraction of an inch of the weathered surface or along a near surface fracture. Such very localized, sooty uranium enrichments are usually less than a few inches in diameter but in pit 9 on zone 5 such sooty mineralization permeates the sandstone adjacent a fracture for a few inches and along the fracture for a foot. This material was coffinite rich and contained 4.7% U_3O_8, 0.28% Cu, 0.38 oz. Ag/T. and 0.20 oz. Au/T. This material appears to be the product of localized enrichment produced by surface weathering processes possibly at the time of alteration of uraninite to coffinite.

Grey to black, pyritic, uranium mineralized sandstone is always associated with oxidized mineralization and local hematite staining. Such localized patches of hematite stained sandstone which occur in contact with or close to reduced mineralization are best exemplified on zone 5 as shown on map 13. Comparison of maps 13 and 14 illustrates a correlation between surface hematite stain and radioactivity. Despite a general spatial association, no consistent geometric relationship between reduced uranium mineralization and hematization can be seen in bedrock trenches or drill core. Grey to black mineralized sandstone and red hematized sandstone may contact with each other or with buff, pink or pale green sandstone.

In drill core hematization does not occur preferentially above or below reduced uranium mineralization either geometrically or stratigraphically. Patches of reduced uranium mineralization and hematization are commonly of similar size and aspect but features suggestive of one having replaced the other are not apparent. In many places hematite staining has been leached back from some but not all fractures in a manner similar to that of the reduced uranium mineralization.

Nonradioactive Reduced Mineralization

A limited amount of nonradioactive, dark grey to black, pyritic sandstone was found in the areas of zones 1, 2, 3 and 6 as well as at pit 2 (map 17). This nonradioactive reduced mineralization was seen only in bedrock trenches and drill core. Surface weathering of this pyritic sandstone on zone 1 has produced limonite staining on the outcrop surface.

The nonradioactive reduced mineralization is similar to radioactive reduced mineralization in that it contains up to a few percent very fine pyrite and traces of galena, chalcopyrite, sphalerite and covellite. The dark grey to black color appears to be due to the presence of coaly carbonaceous material with a refractive index of 1.77 and a reflectance of 7-10% (in air at 546 nanometers). This material forms replacive interstitial networks in the host sandstone (plate 9g) and may comprise up to a few percent of the rock. The carbonaceous material microscopically resembles the coffinite present in uraniferous reduced mineralization and thus leaves in doubt the question of whether carbonaceous material may also be present in the reduced uranium mineralization (compare plate 9e with 9g).

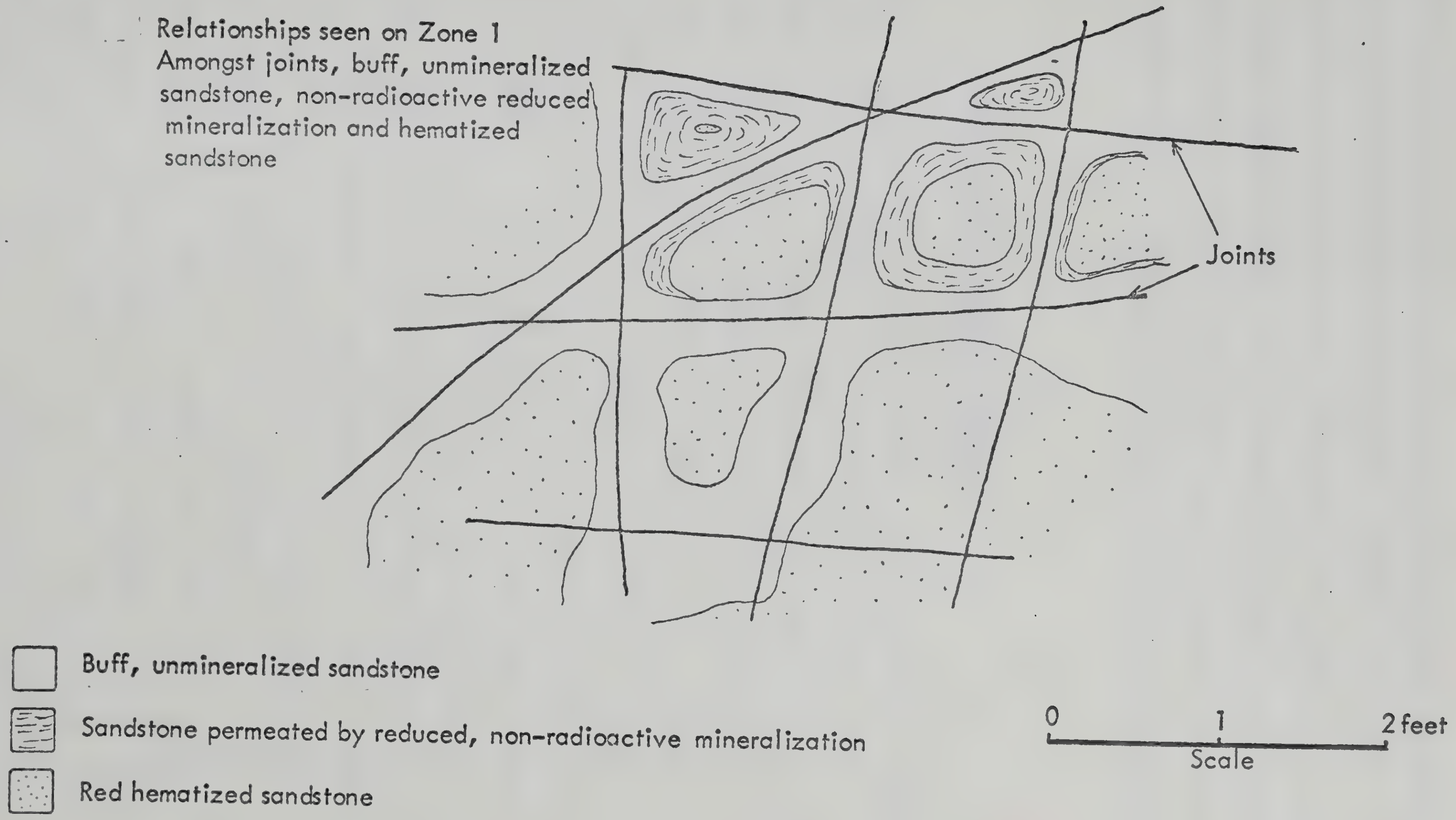
The nonradioactive reduced mineralization shows a consistent geometric

relationship to joints and to red hematized sandstone. The pyritic black sandstone occurs as narrow bands and small bodies directly controlled in size and shape by adjacent joints. Small blocks of sandstone bounded by joints contain either a central body of pyritic black sandstone or an enclosing layer of pyritic black sandstone with a red hematized sandstone core. The layers or bodies of black pyritic sandstone are congruent with but separated from the adjacent joints by a zone of buff unmineralized sandstone. Hematite stained sandstone occurs as cores within enclosing black pyritic bands as well as patches not enclosed or only partially enclosed by black pyritic bands. Some but not all hematized sandstone is separated from adjacent joints by zones of buff, apparently leached, sandstone. These relationships which are illustrated in figure 15, seem to suggest that nonradioactive reduced mineralization invaded previously hematized sandstone from adjacent joints along which the reducing solutions gained access. Subsequently, oxidizing groundwater leached both nonradioactive reduced mineralization and hematite adjacent joints similar to the previously described leaching of reduced uranium mineralization adjacent to joints. Most red hematized sandstone on all zones is not leached adjacent joints and indeed some joints are zones of more intense hematization.

On surface nonradioactive reduced mineralization has been seen only in general association with oxidized uranium mineralization but this may be due to the fact that it can only be seen after rock trenching and rock trenching has only been conducted in areas of anomalous radioactivity. Bands of nonradioactive reduced mineralization which separate hematized sandstone from buff sandstone have been seen in drill core from holes that intersected no radioactivity at all. Zone 7 is the only place in which uraniferous reduced mineralization locally shows a poorly developed

Figure 15.

Relationships seen on Zone 1
Amongst joints, buff, unmineralized sandstone, non-radioactive reduced mineralization and hematized sandstone


Joints
Buff, unmineralized sandstone
Sandstone permeated by reduced, non-radioactive mineralization
Red hematized sandstone
0
1
2 feet
Scale

relationship to hematized sandstone similar to that which is characteristic of the nonradioactive reduced mineralization. On zone 7 much of the black reduced mineralization is only weakly radioactive and perhaps represents a phase of mineralization transitional between the typical highly radioactive reduced uranium mineralization which shows no geometric relationship to hematized sandstone and the nonradioactive reduced mineralization which does.

Relationship Between Oxidized and Reduced Mineralization

The descriptive aspects of the distribution of red hematized sandstone and grey to black pyritic sandstone, both of which may or may not contain uranium, leave little doubt that oxidation and reduction processes played an important role in the formation and evolution of the uranium deposits. Unfortunately the observed relationships do not provide a clear indication of the sequence of events perhaps due in part to extensive postmineralization leaching by near surface groundwater which has left only relicts of reduced uranium mineralization and associated hematization.

The importance of oxidation-reduction reactions in the genesis of sandstone-type uranium deposits has been well documented in the case of the Wyoming and Colorado Plateau type uranium deposits and in this respect the Simpson Islands deposits seem analogous. Although in the Simpson Islands area one cannot document a specific mechanism such as roll formation (Alder, 1964 and Shawe and Granger, 1965) the great degree of diversity and even contrast among Wyoming and Colorado Plateau type deposits (Fisher, 1970) leaves ample room for such a comparison. Like many of the United States' deposits, the Simpson Islands deposits have likely been through a long and complicated history of deposition and modification

by oxidation, transportation and redeposition (Gruner, 1956). In particular, recent weathering and near surface groundwater processes seem to have leached uranium adjacent joints in some areas and in others precipited uranium salts on joints adjacent the present weathering surface. Thus the current distribution of oxidized uranium mineralization may not reflect the original relationship of uranium to hematized and reduced sandstones.

Genesis of Uranium Mineralization

It is not possible to make a conclusive hypothesis for the genesis of the Simpson Islands uranium deposits based on the available evidence. However, alternatives can be considered and certain inferences made. The deposits in their present form are undoubtedly epigenetic and were deposited in the host sandstone by some form of aqueous solution.

The mineralizing solution may have been a hydrothermal phase transported from depth along the major faults of the McDonald system or derived from the intrusive bostonite or albite syenite magmas. The fact that all radioactive zones are located within a thousand feet of a major fault is suggestive; however, on a more local scale there seems to be no relationship between faults and mineralized zones. Perhaps the greater degree of silicification and decreased permeability near faults has resulted in the preservation of uranium deposits or perhaps the greater degree of structural deformation has resulted in exposure of deposits near faults. The regional extensiveness of uranium deposits in Sosan Group strata throughout the East Arm argues against such localized hydrothermal sources. This is also the major argument against a genetic relationship between diatreme activity and uranium mineralization. Another is the occurrence within diatremes of fragments of radioactive sandstone mixed with

nonradioactive fragments in nonradioactive matrix.

It is more likely that the uranium deposits are the result of a regionally extensive process which affected Sosan Group rocks throughout the East Arm. The prehnite grade burial metamorphism which affected the Hornby Channel Formation in the Simpson Islands area created a hydrothermal environment in which remobilization and concentration of uranium may have taken place. However, metamorphic grade should decrease towards the northeast and the stata which host uranium deposits near Reliance should be essentially unmetamorphosed due to thinning of the sedimentary pile towards the northeast.

I favor groundwater processes as the most likely agency of uranium mineralization. Certainly the effectiveness of such processes in producing localized uranium deposits over a regionally extensive area has been well documented in the American southwest and the Simpson Islands deposits show some of the earmarks of such processes. The most favorable time for such processes to form uranium deposits is during a period of subareal weathering and erosion of tilted, sandstone strata, particularily if granitic rocks and pyroclastics are exposed nearby. Such conditions were met during the period of erosion which preceeded deposition of the Et-then Group. A preliminary estimate based on U-Pb isotope studies conducted by H. Baadsgaard (Morton, 1974) indicates the time of uranium mineralization at Reliance was between 1800 and 1550 m.y. ago. This correlates well with Hoffman's (1973) estimate of the age of the sub-Et-then unconformity as approximately 1750 m.y. All the sub-Et-then rocks currently exposed in the southeast side of the East Arm were very close to the erosion surface at that time. Granitic basement rocks of both the Slave and Churchill provinces were exposed for those who favor derivation of uranium from weathering of granites (Gruner, 1956). Tuffs and volcaniclastic

rocks near the base and the top of the Hornby Channel Formation and the Seton Formation volcanics were available for those who favor derivation of uranium from the alteration of volcanic material (Davis, 1970 and Rosholt et al. 1971). Others have suggested that sufficient uranium could be leached from arkosic sandstone by groundwater (Melin, 1964). Perhaps the ubiquitous heavy mineral bands rich in detrital radioactive minerals in the Hornby Channel Formation released uranium to groundwater during oxidation of detrital magnetite to hematite.

The hypothesis that the Simpson Islands uranium deposits formed at the time of the sub-Et-then unconformity has an ancillary implication of interest. Fragments of radioactive sandstone within diatreme breccias on zones 1 and 6 indicate uranium mineralization predated diatreme activity. If the hypothesis is valid then the diatremes must postdate the sub-Et-then Group unconformity. The only shred of supporting evidence for such a young age of diatreme activity comes from map unit L, base line 2. This rock type occurs within diatreme breccias and very much resembles conglomerate from the Murkey Formation of the Et-then Group. However, Reinhardt (1972) considers this rock type a "pseudoconglomerate" a view I don't share but a view which makes the evidence inconclusive.

GENERAL CONCLUSIONS

This study documents the geology and uranium deposits within an area of Aphebian arenites located on Simpson Islands in the East Arm of Great Slave Lake, Northwest Territories. The stratigraphic unit of primary interest is the Hornby Channel Formation which comprises the base of the Great Slave Supergroup. The Hornby Channel Formation is a thick diachronous unit composed principally of conglomeratic subarkose, deposited by braided streams which flowed southwest down the axis of the East Arm. Hornby Channel Formation sandstones were deposited directly upon a paleoregolith developed on Archean granitic and high-grade metamorphic basement rocks.

The geological evolution of the East Arm was profoundly influenced by the McDonald fault system, one of the world's major faults. This essentially dextral transcurrent fault system was active prior to deposition of early Aphebian sediments and produced a trough which influenced sedimentation both locally and regionally. Local effects on sedimentation within the Simpson Islands area include penecontemporaneous deformation features and rapid lateral facies variations which suggest that fault movement during deposition of the Hornby Channel Formation was still transcurrent. At some stage in the evolution of the fault system, a wedge-shaped graben, which has been shown to displace the Mohorovicic discontinuity, developed in the west end of the East Arm. The time of graben development is not known but it is thought that the graben was superimposed upon pre-existent major splays of the transcurrent McDonald fault system. At the end of the Hudsonian orogeny, uplift of the Churchill province was accommodated by movement with a major vertical component on the McDonald system faults which produced a series of fault slices which step up to deeper erosional levels to the south.

Volcaniclastic rocks and air fall tuffs which occur locally along the Simpson Islands fault system comprise the first reported evidence of volcanic activity during deposition of the lower Hornby Channel Formation. Metamorphic mineralogy of one volcaniclastic rock type indicates the Hornby Channel Formation in the west end of the East Arm was subjected to prehnite-pumpellyite-quartz facies burial metamorphism under approximately 30,000 feet of Great Slave Supergroup strata.

A sixteen-mile long differentiated dyke, which is composed of albite-syenite in the thesis area, was intruded along faults of the Simpson Islands fault system after deposition of the Hornby Channel Formation. Two K-Ar isotopic dates of this dyke indicate an age of approximately 2185 million years. A bostonite stock of complex geometry intruded the Hornby Channel Formation along the Simpsons Island fault system close to the petrologically similar albite syenite dyke. The bostonite is spatially and probably genetically related to diatremes which postdate the bostonite. The complex system of diatremes which intruded the Hornby Channel Formation along the Simpson Islands fault system in the thesis area are representatives of widespread diatreme activity which occurred along three major subsystems of the McDonald fault system in the west end of the East Arm. The diatremes in the Simpson Islands area originated in the Archean basement and involved sedimentary rocks from at least one formation other than the Hornby Channel Formation. The diatreme breccias are highly variable and are associated with extensive in situ brecciation of adjacent Hornby Channel Formation sandstone which in places was intruded by breccia dykes. Development of the diatremes involved explosive activity and fluidization processes as well as possibly hydraulic fracturing. The diatremes are associated with extensive albitization of comminuted quartzo-feldspathic breccia matrix and adjacent sandstone. Sandstones within a couple of

thousand feet of the major McDonald system faults show evidence of widespread silicification and albitization.

Uranium deposits in the thesis area occur in sandstones at various stratigraphic levels within the Hornby Channel Formation but most occur within a thousand feet of a major McDonald system fault. The uranium mineralization is divided into two types for descriptive purposes. Reduced uranium mineralization is characterized by interstitial, very fine grained pyrite and uraninite within grey to black sandstone. Uraninite occurs in various states of oxidation and has commonly been altered to amorphous coffinite. Minor chalcopyrite and galena are commonly present as well as traces of cobaltite, arsenopyrite, hematite, anatase and covellite. Uranium content commonly ranges from 0.5 to 1.5% U_3O_8. The reduced uranium mineralization is epigenetic, has a patchy distribution, and is associated with morphologically similar patches of red hematized sandstone. A limited amount of non-radioactive pyritic sandstone which contains carbonaceous material occurs in places and is not directly associated with reduced uranium mineralization. Both uraniferous and non-uraniferous pyritic sandstones have been leached by groundwater adjacent to joints.

Oxidized uranium mineralization is characterized by secondary uranyl salts which occur interstitially and coat joints in both red (hematized) and buff-coloured sandstones. The concentration of secondary uranyl minerals is commonly higher adjacent the present weathering surface and reflects recent redistribution by groundwaters.

The Simpson Islands uranium deposits may have been formed by groundwater processes in a manner analogous to the epigenetic sandstone type deposits of Wyoming or the Colorado Plateau. This mineralization may have occurred during the erosional hiatus represented by the unconformity at the

base of the Et-then Group about 1750 m.y. ago when the Hornby Channel Formation in the Simpson Islands area was exposed to subaerial weathering conditions.

PLATE 1

a) Longitudinal section view of a trough cross-bed set which contains a lag gravel deposit in its base. Hornby Channel Formation.

b) Hematite laminae in Hornby Channel Formation sandstone disrupted by soft sediment deformation. The photo covers a 5 ft. width.

c) Coarse and fine sandstones of the Hornby Channel Formation showing disrupted bedding due to soft sediment deformation.

d) Irregularily mixed coarse and fine sandstone and hematite laminae due to soft sediment deformation of the Hornby Channel Formation.

e) Fragment of stromatolitic dolomite in a stage 3 breccia at the west end of base line 1.

f) Fragment of stromatolitic dolomite in a stage 3 breccia at the west end of base line 1.

PLATE I

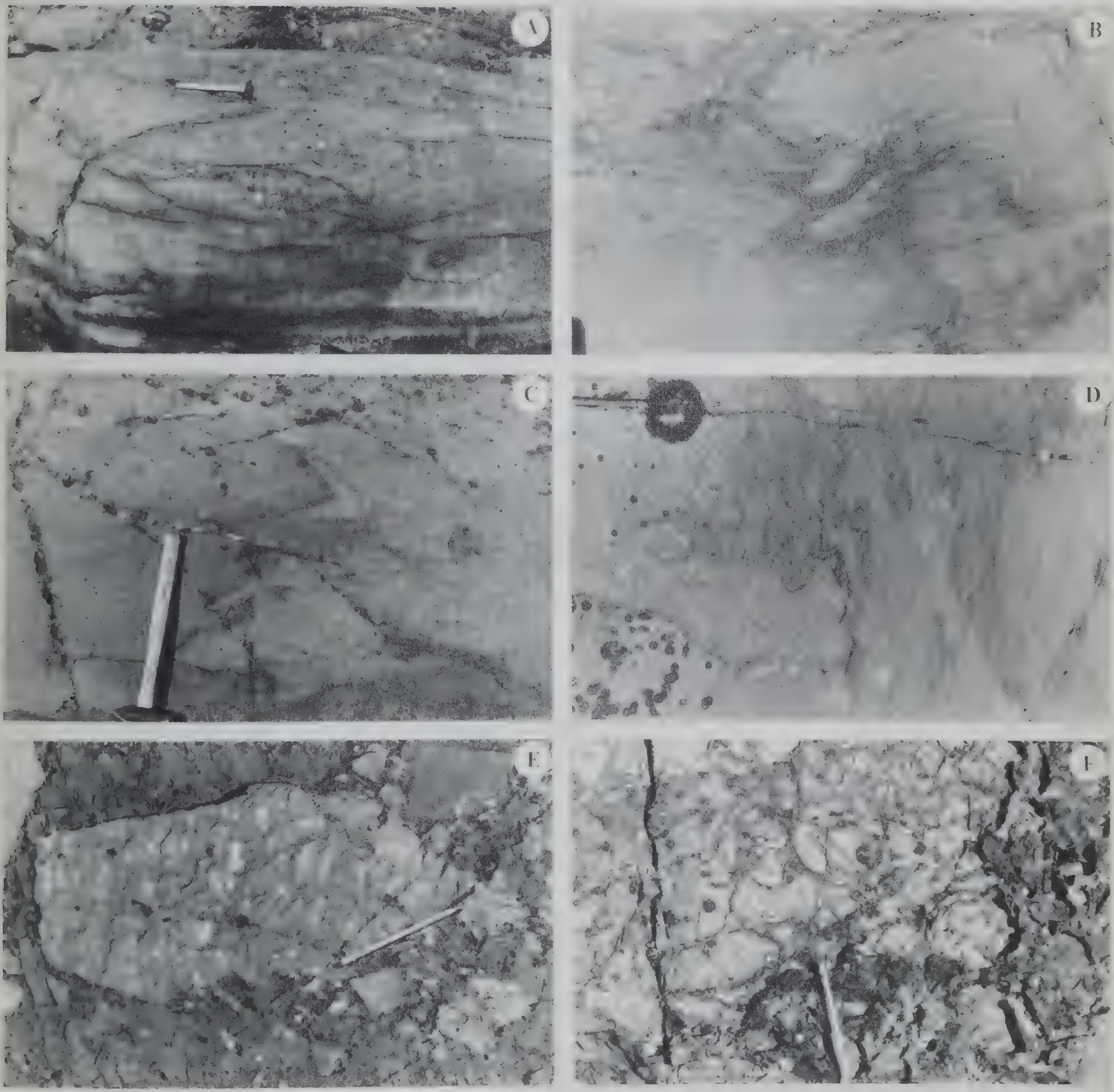


PLATE 2

a) Stage 1 brecciated sandstone of the Hornby Channel Formation.

b) Narrow breccia seam transecting stage 1 brecciated sandstone. The breccia seam is composed of angular sandstone fragments in a matrix of comminuted, quartzo-feldspathic material. From the same outcrop as plate 2a.

c) Stage 2 sandstone breccia with carbonated, comminuted matrix.

d) Stage 3 breccia composed of predominantly sandstone fragments in a siltstone rich matrix. The largest fragments are a few feet across.

e) Stage 3 breccia composed of predominantly dolomite and siltstone fragments in a siltstone rich matrix. Fragments range up to several feet across.

f) Stage 3 breccia composed of dolomite, siltstone, sandstone and bostonite clasts.

g) Stage 3 breccia composed principally of dolomite and siltstone. Maximum fragment size is several inches.

h) Stage 3 breccia composed principally of dolomite and siltstone. More distant view of same exposure as plate 2g.

PLATE 2

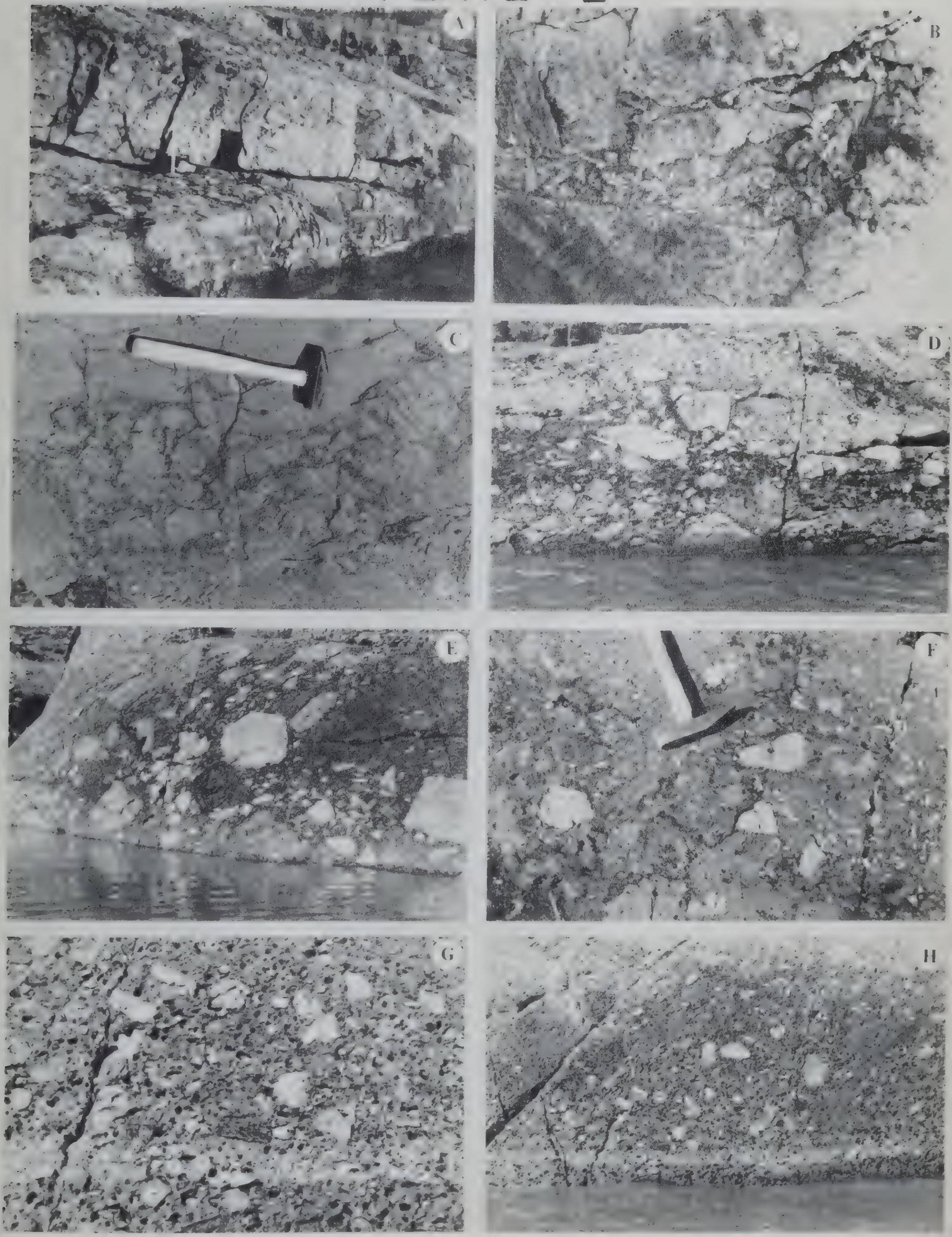


PLATE 3

a) Bostonite outcrop showing abundant dolomite filled fractures and a minor shear plane.

b) Contact between bostonite and Hornby Channel Formation sandstone showing abundant large xenoliths of sandstone in the bostonite. The photo covers a 6 foot width.

c) Stage 2 bostonite breccia.

d) Dolomitized, banded microbreccia dyke which separates unbrecciated Hornby Channel sandstone above from stage 1 brecciated sandstone below.

e) Banded microbreccia dyke showing deviation of banding at a sharp irregularity in one side of the dyke.

f) Close up of a portion of plate 3e showing banding in the microbreccia dyke.

g) Margin of a body of dolomitized, albitized, stage 3 breccia with siltstone and comminuted matrix. Albitized Hornby Channel Formation sandstone is at the left. Stage 3 breccia is on the right. Dolomitized banded microbreccia occupies the center. See plate 6g for photomicrograph.

h) Close up of plate 3g showing contact between banded microbreccia margin and stage 3 breccia interior of the breccia "pipe".

PLATE 3

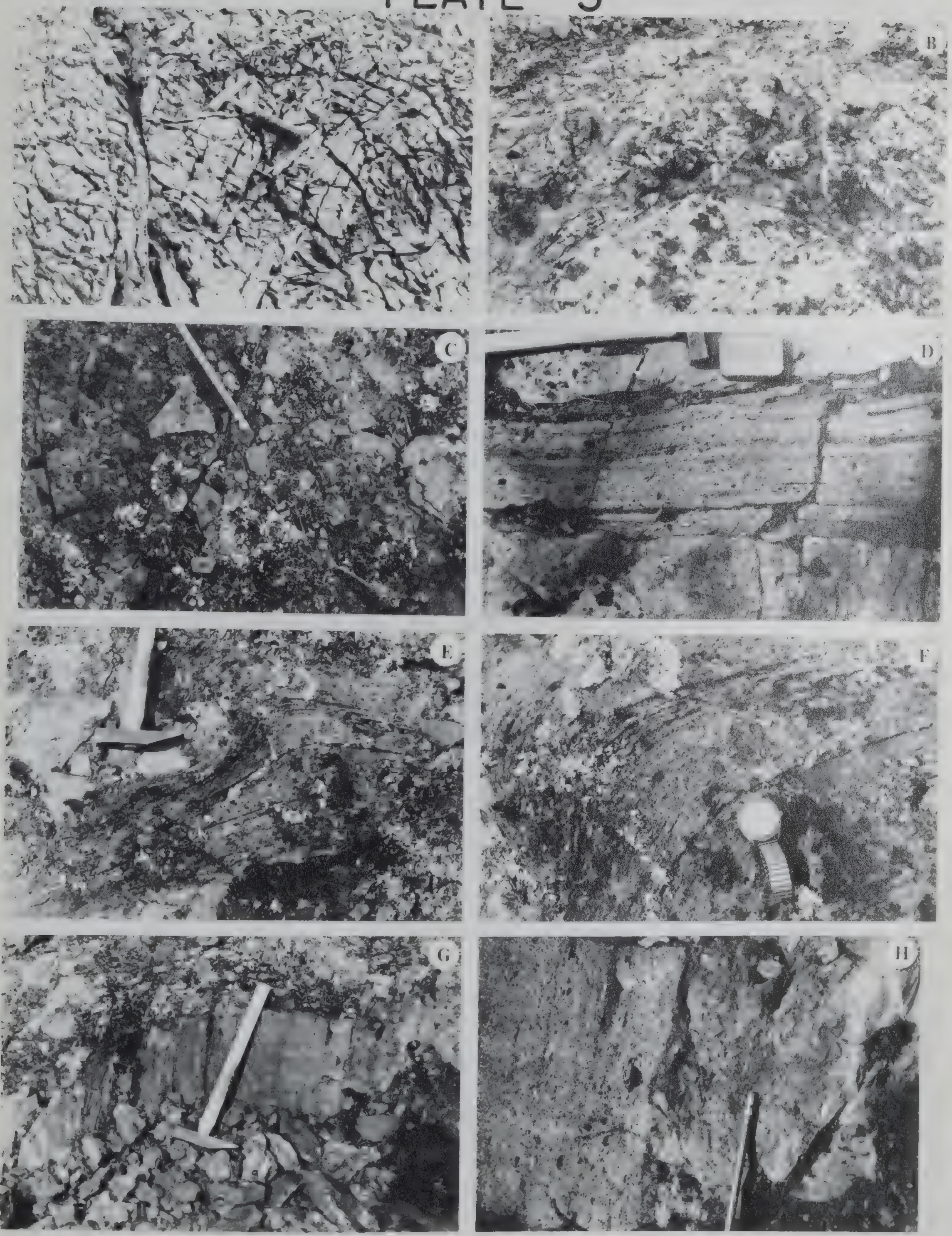


PLATE 4

a) Photomicrograph of paleoregolith showing partial sericitization of a microcline crystal. Crossed nicols.

b) Photomicrograph of highly altered paleoregolith showing quartz and microcline grains floating in sericite matrix. Crossed nicols.

c) Photomicrograph of bostonite showing trachoidal texture of albite laths. Crossed nicols.

d) Photomicrograph showing bimodal sorting and angularity of a sample from the unit of disrupted and mixed sandstone lithologies (unit T) in the base line 1 area. Plane polarized light.

e) Photomicrograph of hematitic pelletoid chert from unit I, base line 2. A portion of a replacive sphere of chalcedony and carbonate occupies the lower left. Plane polarized light.

f) Photomicrograph of a volcanic clast from the volcanic sandstone of unit N, base line 1. The volcanic has been completely altered to spherulitic prehnite and chlorite with a little carbonate. Plane polorized light.

g) Photomicrograph of a volcanic clast from the volcanic sandstone of unit N, base line 1. The volcanic has been completely altered to sericite with a spherulitic texture. Plane polarized light.

h) Photomicrograph of pale green mudstone from a lens within the Hornby Channel sandstone at zone 5. A relict spherulitic texture is visible in the distribution of sericite and geothite(?). Plane polarized light.

PLATE 4

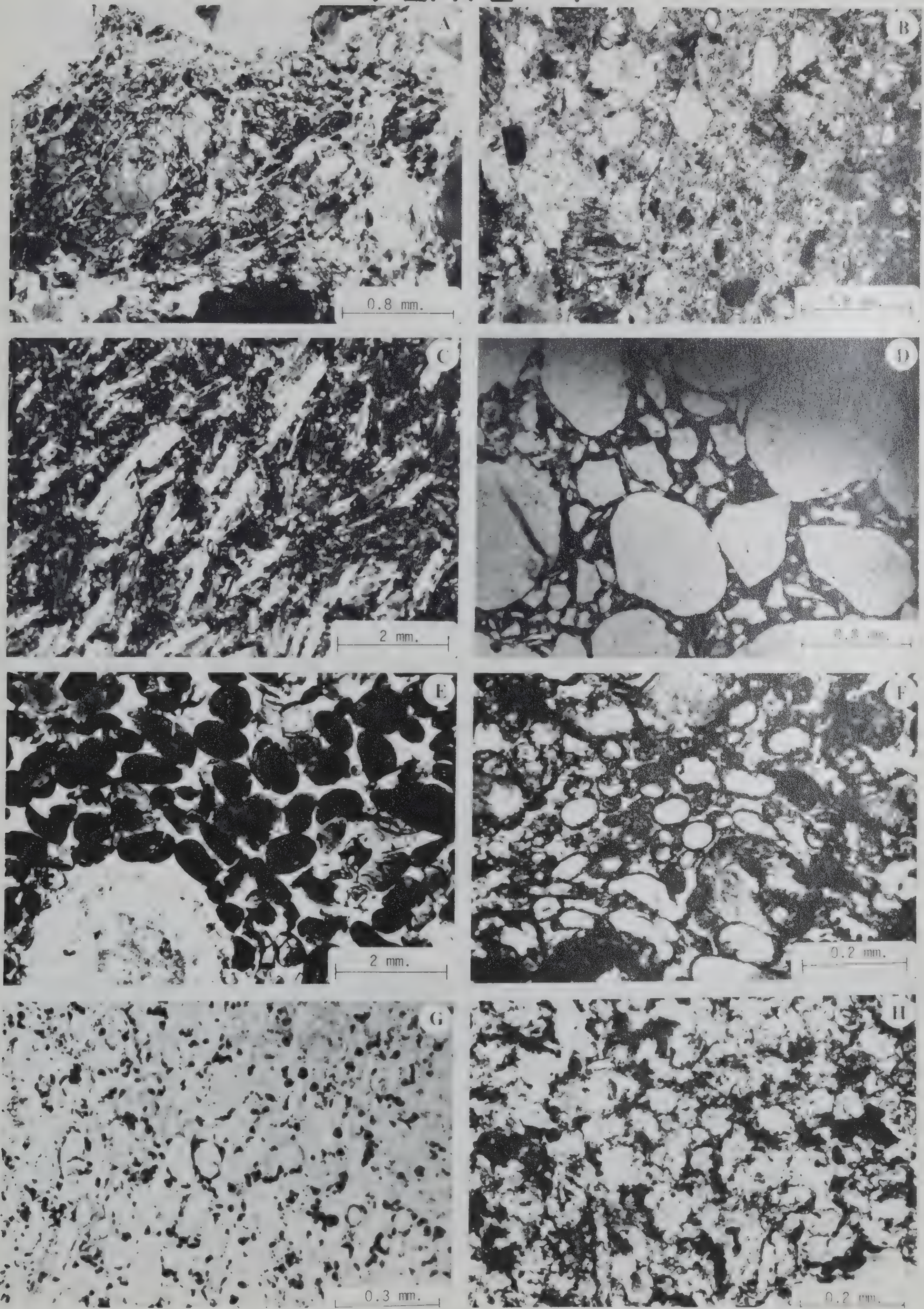


PLATE 5

a) Contact of a fracture filling in stage one brecciated sandstone. The fracture filling, on the left, is comminuted quartzo-feldspathic material. Plane polarized light.

b) Photomicrograph of a breccia dyke with albitized comminuted matrix predominant. Fragments are predominantly sandstone, quartz, plagioclase and microcline. A clast of granitic blastomylonite occupies the right side. Map unit O, base line 2. Plane polarized light.

c) Photomicrograph of a breccia dyke with albitized comminuted matrix predominant. Orientation of tabular quartz and feldspar clasts and muscovite porphyroblasts defines a flow texture in the comminuted matrix between porphyroclasts of quartzite and sandstone. Map unit O, base line 2. Plane polarized light.

d) Photomicrograph of a breccia with albitized comminuted matrix predominant. A radiating aggregate of quartz porphyroblasts occurs in the center embedded in dolomitized and albitic, comminuted quartzo-feldspathic matrix. Map unit X, base line 1. Crossed nicols.

e) Photomicrograph of a breccia dyke with albitized comminuted matrix predominant. Euhedral quartz porphyroblasts (white) occur in the dirty albitic matrix. The larger dark patches are siltstone fragments. Map unit O, base line 2. Plane polarized light.

f) Photomicrograph of the matrix of a dolomitzed, albitized, stage 3 breccia with siltstone and comminuted matrix. A zoned, euhedral, secondary quartz crystal is at the center. Map unit S, base line 2. Plane polarized light.

g) Photomicrograph of the matrix of a breccia dyke with albitized comminuted matrix predominant. At center is a diagonal muscovite porphyroblast in the dolomitized and albitized matrix. Map unit O, base line 2. Plane polarized light.

h) Photomicrograph of the matrix of a breccia dyke with albitized comminuted matrix predominant. At center is a lath shaped albite porphyroblast (almost at extinction) set in a matrix of microcrystalline anhedral albite which contains recrystallized quartz, secondary dolomite and quartz clasts. Map unit O, base line 2. Crossed nicols.

PLATE 5

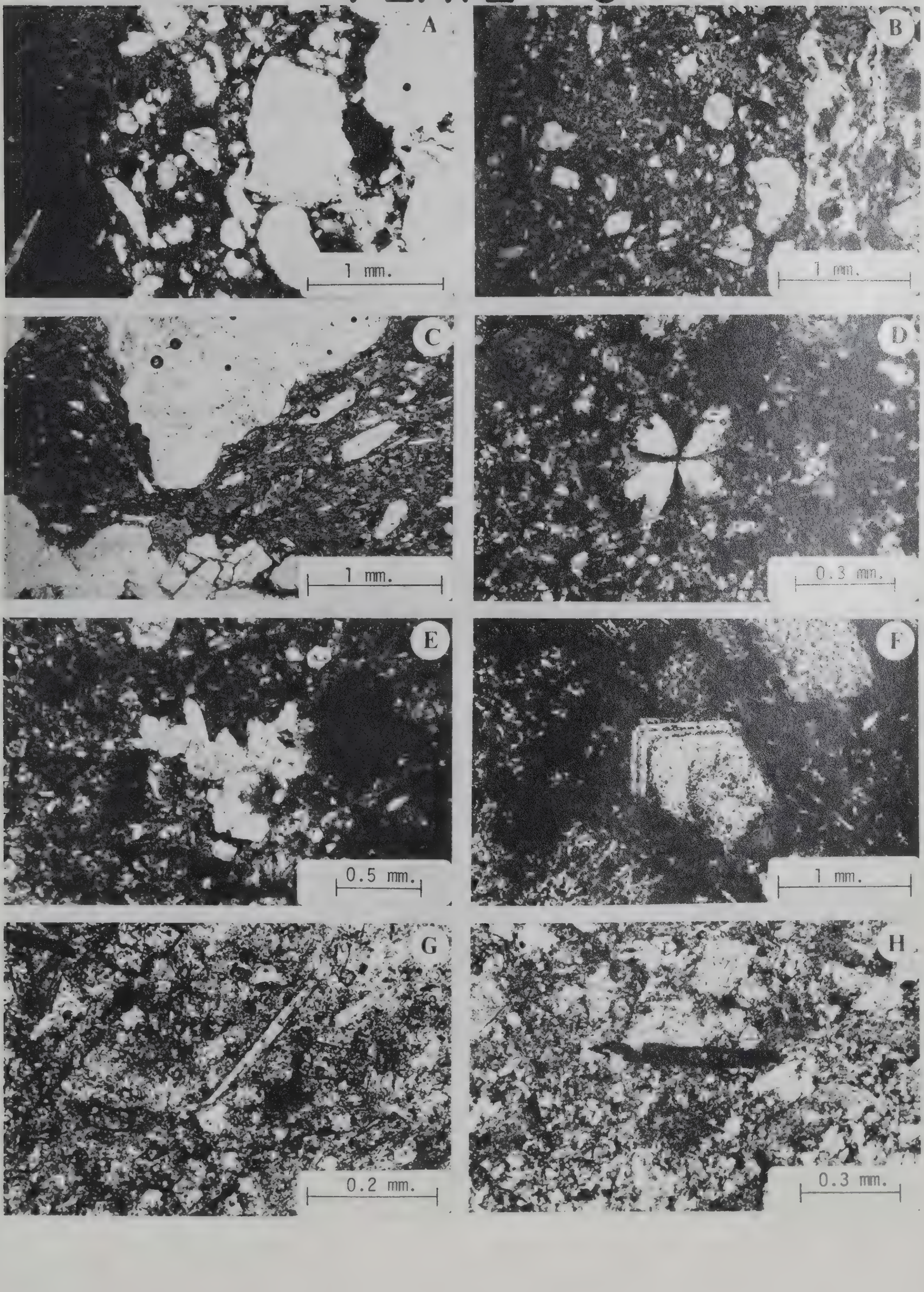


PLATE 6

a & d)Photomicrographs showing microcrystalline mosaic of secondary albite between siltstone clasts in a stage 3 breccia from north of cliffed straits. Siltstone clasts are labeled S, wedge shaped high relief crystals in the albite cement are carbonate. A is in plane polarized light, b with crossed nicols.

c & d)Photomicrographs showing the contact zone between a patch of completely recrystallized secondary albite on the left and the partially recrystallized, albitized, comminuted matrix of a breccia dyke on the right. Map unit S, base line 2. A is in plane polarized light, b with crossed nicols.

e) Photomicrograph of a partially albitized dolomite clast from a dolomitized, banded microbreccia marginal phase of a stage 3 breccia "pipe". Random fine laths of albite have extensively replaced the dolomite within this clast. Plane polarized light.

f) Photomicrograph showing development of euhedral, secondary quartz and carbonate porphyroblasts in the albitized, very fine matrix of a dolomitized banded microbreccia. This microbreccia comprised matrix for large granitic porphyroclasts in a breccia zone at the contact between basement and Union Island Group sediments north of Ref Peninsula. Plane polarized light.

g) Photomicrograph of a banded microbreccia marginal phase of a stage 3 breccia "pipe". The fine grained bands are weakly recrystallized sericitic, albitic and quartzitic material. The coarse bands contain porphyroclasts of dolomite, sandstone and siltstone in a matrix where quartz, albite and dolomite have been extensively recrystallized to coarser grain size. Same location as plate 3g. Plane polarized light.

h) Photomicrograph of a contact between extremely fine, albitized, comminuted, quartzo-feldspathic rock (left) and extensively recrystallized albitized comminuted rock (right). Recrystallization has imparted a coarser secondary texture. From a body of stage 3 breccia, map unit S, base line 2. Crossed nicols.

PLATE 6

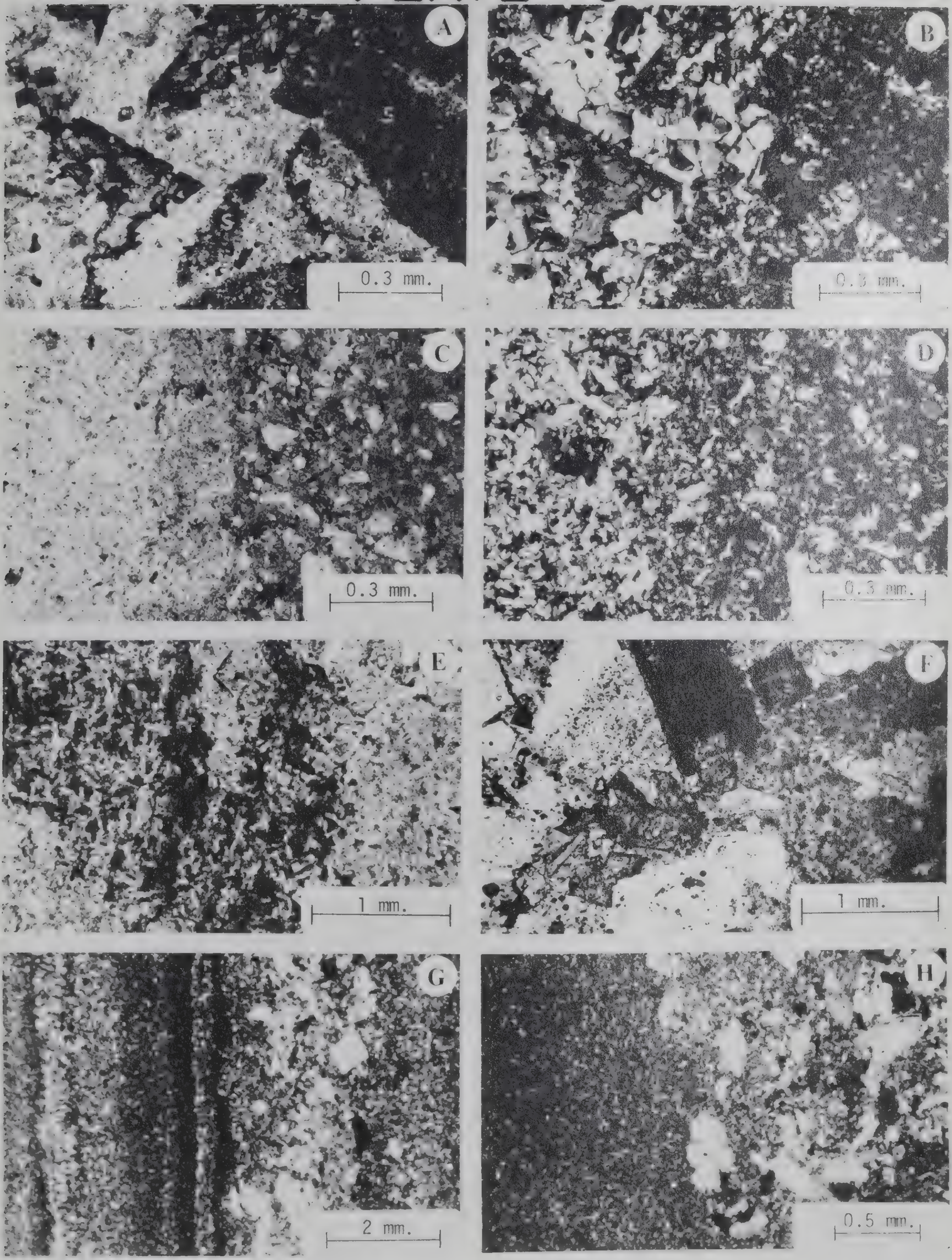


PLATE 7

a) Photomicrograph of a partially albitized, detrital orthoclase grain in Hornby Channel Formation sandstone. Albite (black) rims a nucleus of orthoclase. Crossed nicols.

b) Photomicrograph of a partially albitized detrital orthoclase grain in sandstone adjacent to a fracture filled with albitized comminuted quartzo-feldspathic material. The fracture filling occupies the left half, sandstone the right. The large detrital feldspar at center is orthoclase where stained dark around the right side and albite where medium grey on the left and center of the grain. Albitization appears to have spread from the fracture filling into the sandstone. Plane polarized light.

c) Photomicrograph of an albite veinlet which transects Hornby Channel Formation sandstone. Note finer grained albite at edge of veinlet and introduction of very fine albite into the matrix of the sandstone adjacent the veinlet. Crossed nicols.

d) Photomicrograph of albitized sandstone of the Hornby Channel Formation. Albite is stained dark grey. It replaced and overgrew detrital potassium feldspar grains and in part replaced quartz. Plane polarized light.

e) Photomicrograph of sericitic alteration of feldspar surrounding opaques in a sample of reduced mineralization in Hornby Channel sandstone from zone 5. Plane polarized light.

g) Photomicrograph of Hornby Channel Formation sandstone showing a quartz overgrowth on a detrital quartz grain. Crossed nicols.

h) Photomicrograph of a silica cemented Hornby Channel Formation sandstone which contains stylolitic sutures due to pressure solution. Plane polarized light.

PLATE 7

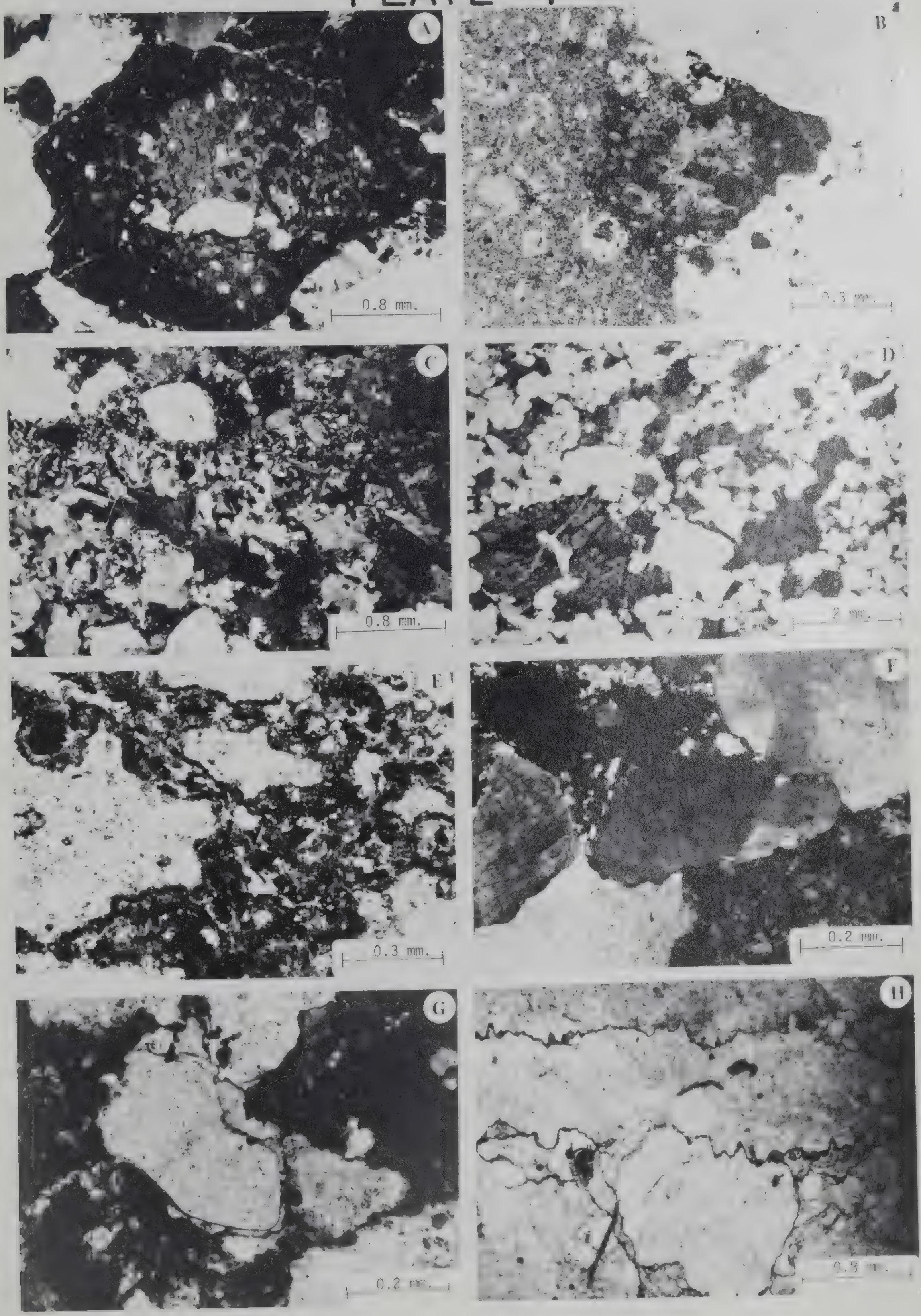


PLATE 8

Autoradiographs of reduced uranium mineralization in conglomeratic sandstones. Dark spots indicate the presence of radioactive minerals. Note the presence of radioactive minerals in hairline fractures transecting quartz clasts as well as in the matrix. Autoradiographs of Blind River ore indicate an absence of radioactive minerals in fractures that cut quartz clasts (Roscoe, 1969). Scale is 0.85 x actual size.

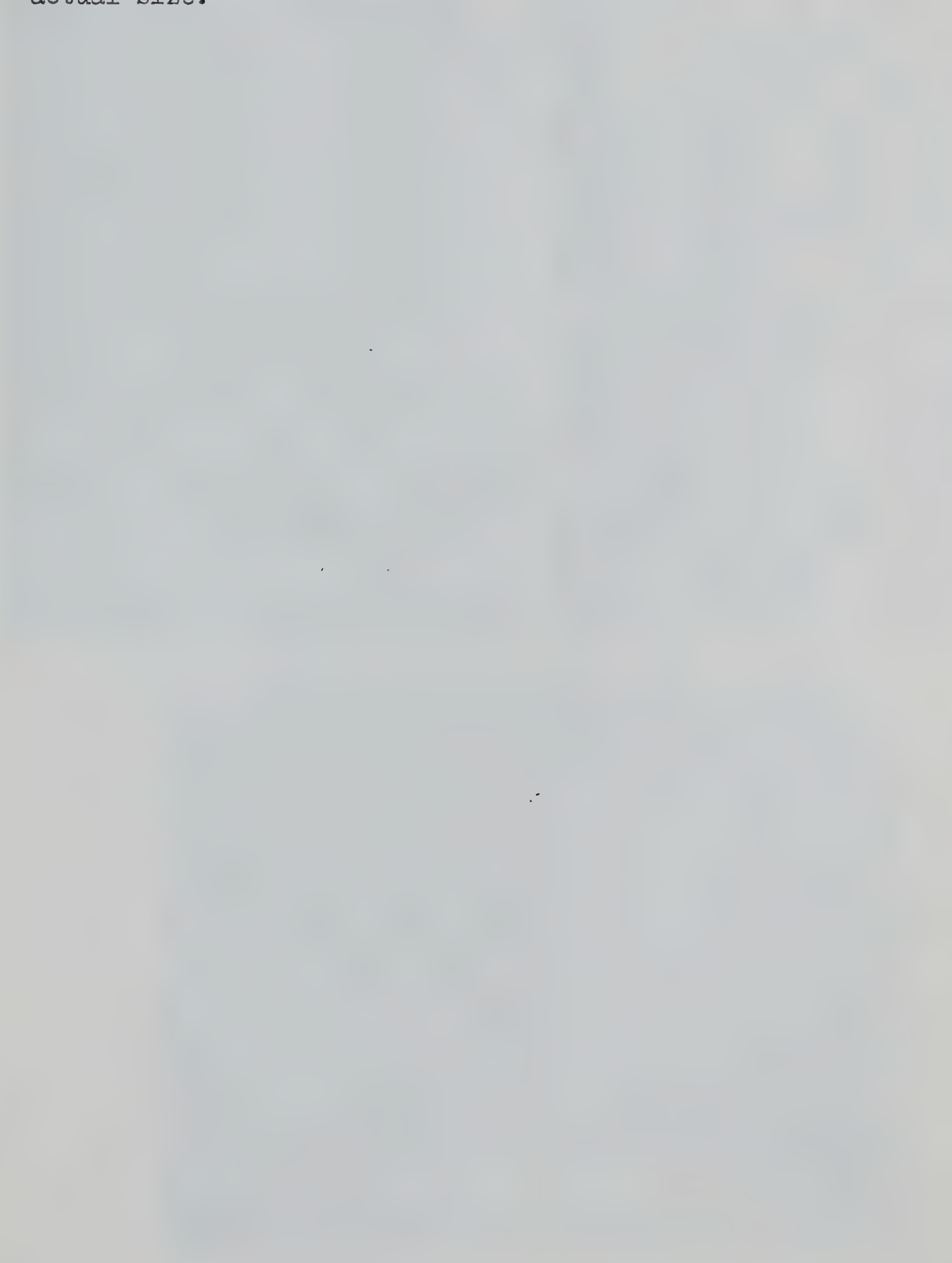


PLATE 8

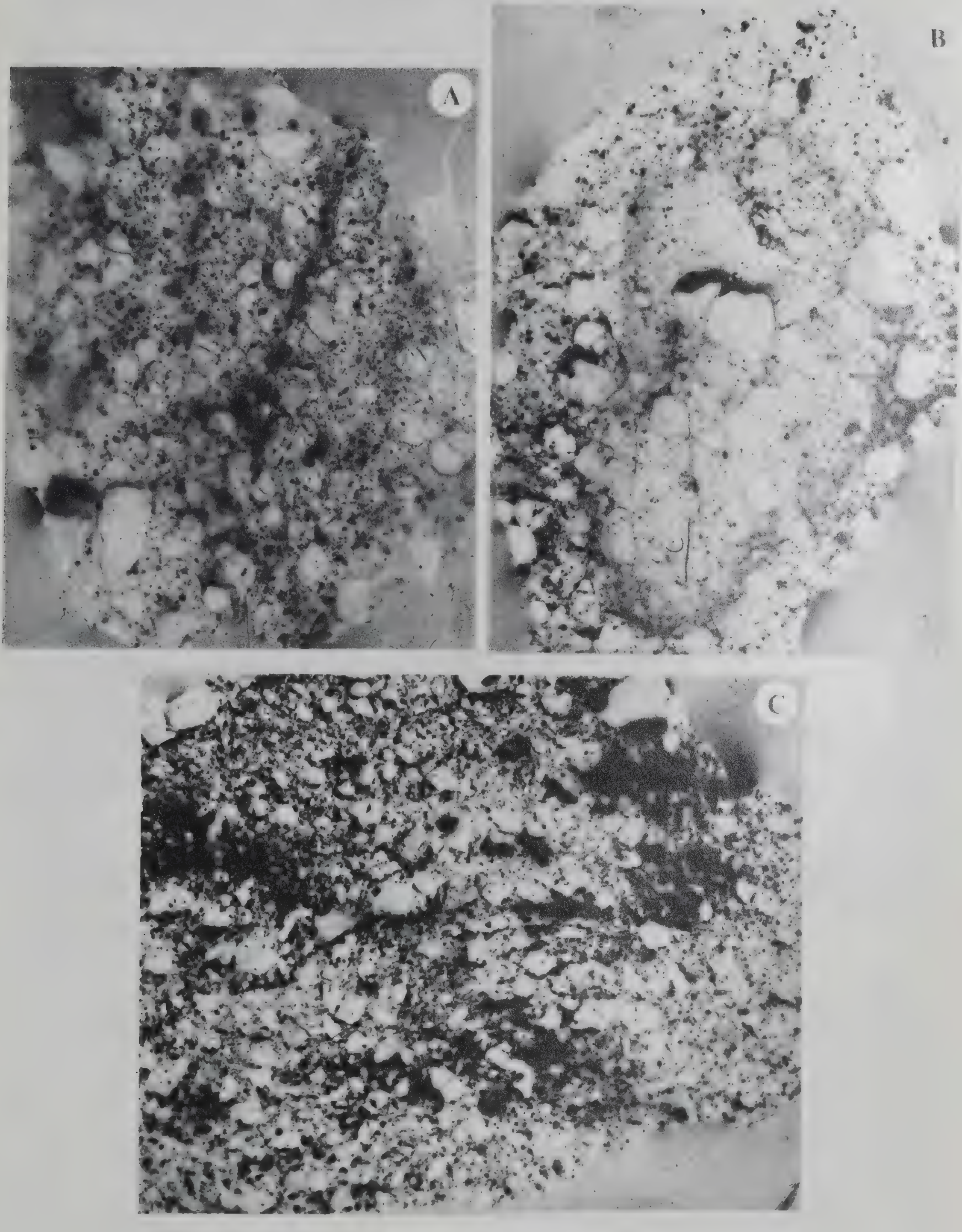


PLATE 9

a) Photomicrograph of a grain of uraninite partially altered to coffinite. Uraninite is light to medium grey, coffinite is black. A thin layer of pyrite (white) partially rims the composite grain. Plane polarized incident light, oil immersion.

b) Photomicrograph of uraninite (light to medium grey) partially altered to coffinite (black) with a partial rim of pyrite (white). Plane polarized incident light, oil immersion.

c) Photomicrograph of pyrite (white) which has been partially replaced by uraninite which in turn has been almost completely altered to coffinite. The dashed white line marks the outer boundary of coffinite (black) which contains minor relict uraninite (dark grey). Plane polarized incident light, oil immersion.

d) Photomicrograph of pyrite (white) rimmed by a thin layer of second generation pyrite which is separated from the earlier pyrite by a thin discontinuous layer of coffinite (black). The dark grey grains to the left are uraninite which is partially altered to coffinite.

e) Photomicrograph of an irregular interstitial network of coffinite (medium grey) which contains a little relict uraninite (light grey) near the center of the photo. The white grains at upper center and right center are patches of lead from the lap. Plane polarized incident light, in air.

f) Photomicrograph of arsenopyrite or safflorite (white) associated with uraninite (medium to dark grey) which has been partially altered to coffinite (very dark grey rims). Plane polarized incident light, in air.

g) Photomicrograph of irregular network of carbonaceous material in nonradioactive black pyritic sandstone. Only trace pyrite (white) is present in the photograph area. Plane polarized incident light, in air.

h) Photomicrograph of a zircon rich hematite lamination in sandstone. Hematite grains are black, quartz is white, three high relief zoned zircon grains occur in a horizontal line across the center of the photo. Plane polarized transmitted light.

PLATE 9

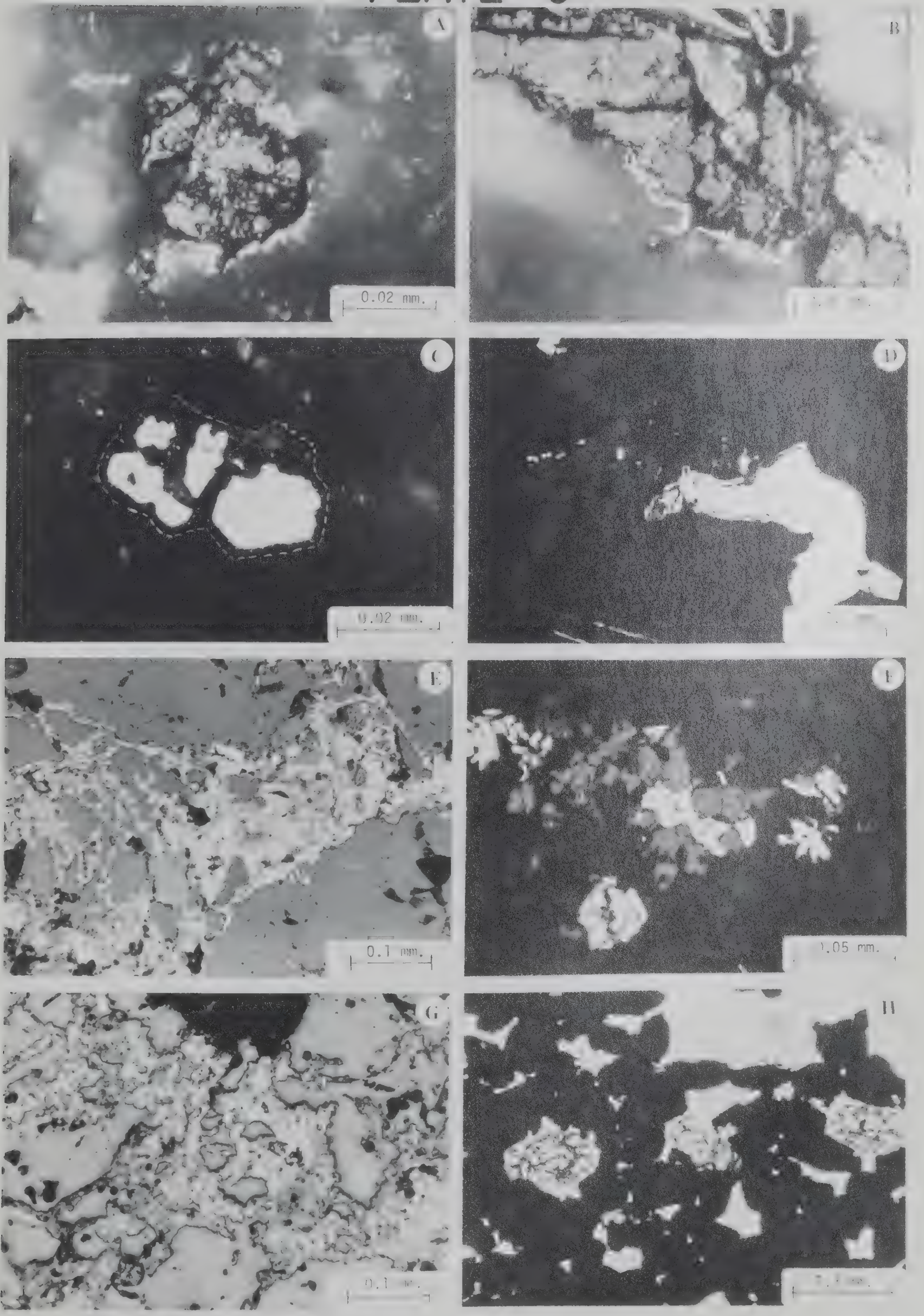


PLATE 10

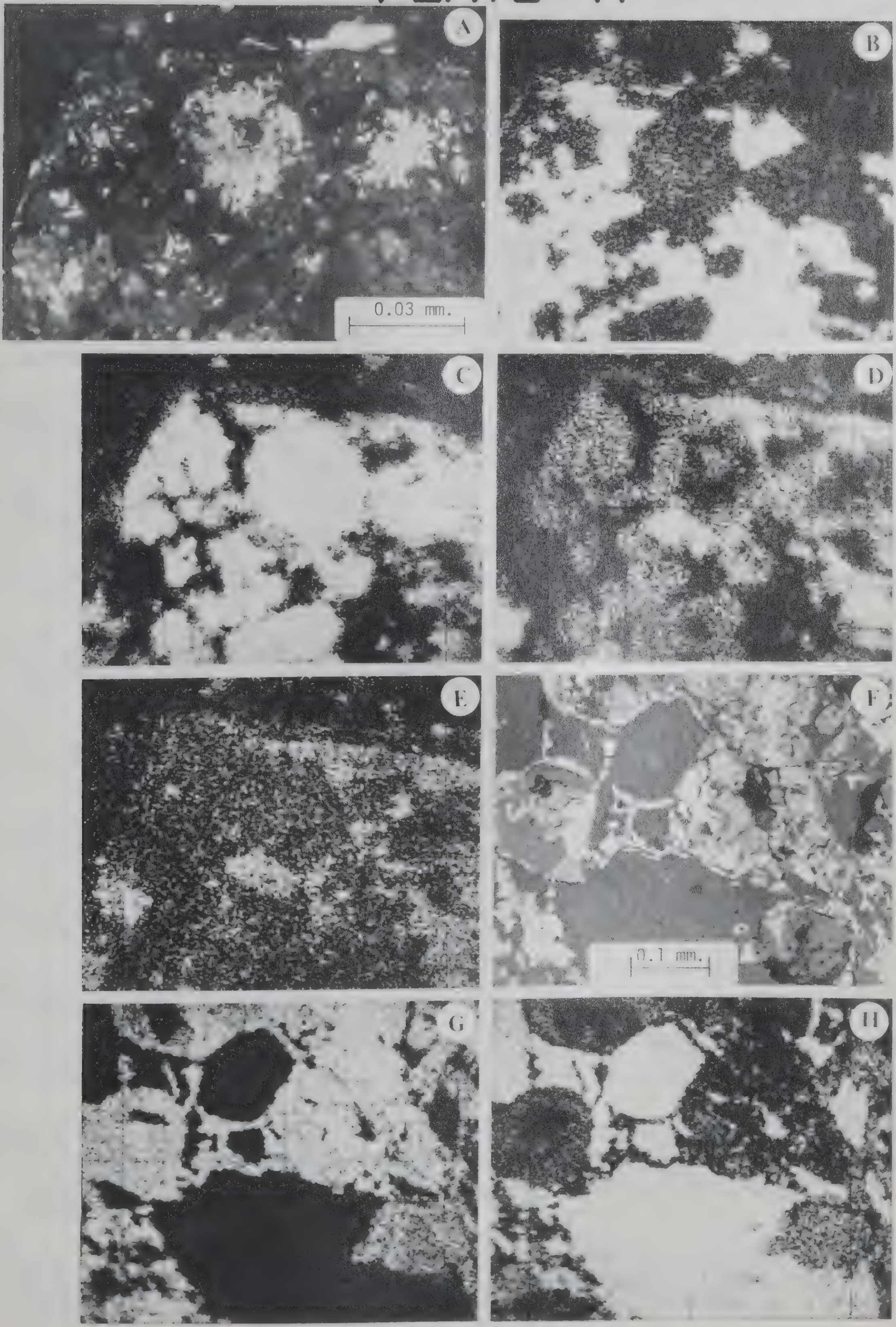
a) Photomicrograph of uraninite (light to medium grey) partially altered to coffinite (very dark grey). Carbonate (black) occurs interstitial to uranium minerals. Plane polarized incident light, oil immersion. Sample from the Reliance area.

b to e) Electron microprobe x-ray photographs of the same area as in "a" above. B shows distribution of calcium, c shows distribution of uranium, d shows distribution of silicon and e shows distribution of iron.

f) Photomicrograph of uraninite (light to medium grey) partially altered to coffinite (dark grey). Quartz is very dark grey. Plane polarized incident light, in air. Sample from zone 5, Simpson Islands area.

g & h) Electron microprobe x-ray photographs of the same area as in "f" above. G shows distribution of uranium, h shows distribution of silicon.

PLATE 11



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APPENDIX 1

HORNBY CHANNEL FORMATION
STRATIGRAPHIC SECTIONS

Section 1: Basal section of Hornby Channel Formation at the northwest side of the Hornby Channel Formation exposure on South Simpson Island.

Rock Unit Description	Thickness in Feet	
	Unit	Total
Feldspathic, slightly conglomeratic sandstone: buff to brownish to red hematized, medium to coarse and fairly well sorted with 5% pebbles and cobbles of quartz, quartzite, granite, siltstone and green shale, sericite cement, sandpaper weathered surface, thin to medium bedded, no hematite laminations, occasional hematite cemented nodules near base.	10+	42+
Overburden	10	32
Orthoquartzite: buff to reddish, fine to medium, well sorted, siliceous cement, locally subfeldspathic with some sericite cement, thin to medium bedded, locally contains hematite cemented nodules up to 1.5 inches across which occasionally have bleached cores and diffuse tails.	5	22
Subfeldspathic to feldspathic, locally conglomeratic sandstone: buff to reddish to brownish medium to very coarse and well sorted to fair sorted with locally up to 30% pebbles and cobbles of quartz, quartzite, granite, siltstone, green shale, mylonite and felsic volcanic (?), conglomerate phase show bimodal sorting with no granules, medium bedded, crossbedded, locally contains hematite cemented nodules towards top.	10	17
Overburden	2	7
Orthoquartzite: white to light pink, fine to medium, well sorted, strong to moderate siliceous cement, generally weaker cement towards top.	5	5
Overburden	30-40	
Garnet-biotite granite gneiss		

Section 2: Hornby Channel Formation section measured from north of the west end of Paddlefish Bay to the end of Susanne Peninsula on South Simpson Island. Approximate thickness of major units was measured from air photographs based on an estimated average dip of 10°.

Rock Unit Description	Thickness in Feet	
	Unit	Total
Slightly conglomeratic sandstone: buff, medium to very coarse, locally no gravel, siliceous cement, abundant hematite laminations and crossbeds, local limonite stained patches due to minor pyrite, lower contact very gradational	600+	3940+
Generally conglomeratic sandstone: buff, medium to very coarse, fair sorted to poor sorted, locally granule conglomerate, siliceous cement, quartz and sandstone clasts, abundant crossbeds and hematite laminations, local hematite stained spots due to pyrite, local limonite stained patches up to 30 feet across, lower contact very gradational.	500	3340
Slightly conglomeratic to conglomeratic sandstone: buff, medium to very coarse sand with granules and minor pebbles, fair to poor sorted, subfledspathic, siliceous cement, locally conglomerate, abundant crossbeds and hematite laminations, lower contact very gradational.	350	2840
Sandstone: buff, medium to very coarse, locally slightly conglomeratic, fairly well sorted, principally siliceous cement with a little sericite, subfeldspathic, massive to thick bedded, abundant crossbeds and hematite laminations.	610	2490
Fault: marked by thin mylonitic quartz vein, thought to be minor and not significantly offset section.		
Slightly conglomeratic to conglomeratic sandstone: buff, medium to very coarse, fair to poor sorted, 5 to 10% gravel, occasional sandy conglomerate lenses, pebbles are quartz, quartzite, sandstone and argillite, strong	530	1880

Section 2 (cont'd)

Rock Unit Description	Thickness in feet	
	Unit	Total
Slightly conglomeratic to conglomeratic sandstone (cont'd): silica and sericite cement, common hematite laminations and crossbeds, rarely hematite stained, lower contact very gradational.		
Sandstone to slightly conglomeratic sandstone: buff, rarely red hematite stained, medium to coarse, fair sorted, subfeldspathic, occasional thin conglomeratic beds, bimodal sorted with pebbles in sand but few granules, pebbles are quartz, quartzite, sandstone and argillite, strong silica and sericite cement, occasional hematite laminations and crossbeds. This unit contains a 2 foot thick, overburden covered, recessive bed approximately 130 feet above the base, lower contact very gradational.	400	1350
Sandstone: white to buff, medium to coarse, fair to well sorted, slightly feldspathic to subfeldspathic, moderate to strong siliceous cement, rare thin pebbley horizons with bimodal sorting, minor granitic clasts becoming very rare towards top of unit, massive with dark hematite laminations, lower contact very gradational.	380	950
Sandstone: buff to brownish to red hematite stained, medium to coarse, fair sorted, subfeldspathic, sericite cemented, sandpaper weathered surface, locally slightly conglomeratic to conglomeratic with bimodal sorting due to minor granules, pebbles mostly quartz and minor granite, massive to thick bedded, lower few feet have siliceous cement.	520	570
Conglomeratic sandstone: strongly hematized red, medium to very coarse, poor sorted, weakly cemented, bimodal sorting with up to 30% pebbles and cobbles of quartz, quartzite, silt, granite and chert or mylonite, minor granules.	1	50
Sandstone: reddish to purple, fine to medium, well sorted, siliceous cement, occasional hematite cemented nodules up to two inches across, some with light colored cores, at about center of unit is a horizon of 5%	10-15	50

Section 2 (cont'd)

Rock Unit Description	Thickness in feet	
	Unit	Total
Sandstone (cont'd): hematized nodules, laminated by color banding, common bleached mottles parallel bedding.		
Slightly conglomeratic sandstone: hematized dark red, medium to coarse, fair sorted, subfeldspathic, sericite and silica cemented.	5	35
Orthoquartzite: white to pale pink, fine to medium, well sorted, siliceous cement, thin bedded and somewhat flaggy, local pink laminae.	15	30
Overburden	10--20	10--20
Biotite - granite gneiss		

Section 3: Basal Hornby Channel Formation exposed on Contact Island southwest of Wilson Island.

Rock Unit Description	Thickness in feet	
	Unit	Total
Lake		
Sandstone and conglomeratic sandstone: buff, medium to granule, poor to fair sorted, orthoquartzitic to subfeldspathic, silica and sericite cement, abundant festoon crossbeds, common hematite laminations, minor pyrite common, large limonite stained patches up to 30 feet across are common towards top of unit.	130+	333+
Dolomite cemented conglomeratic sandstone: coarse, fair sorted, brown to buff.	10	203
Conglomeratic sandstone: buff to brown, fair sorted, coarse to granule.	10	193
Sandstone: buff, medium to coarse, fair sorted.	10	183
Orthoquartzite: white to buff, fine to medium, well sorted, thin bedded, siliceous cement, locally contains up to 15% red hematite stained spots 0.5 to 1 mm across.	65	173
Overburden	10	108
Sandstone: buff, medium to coarse, fair sorted, contains 10% hematite stained spots up to 2 mm.	20	98
Sandy pebble conglomerate: 45% well rounded pebbles of sandstone and quartzite in a matrix of coarse to very coarse arkosic sand.	3	78
Dark red siltstone: fissile, hematitic, micaceous.	2	75
Sandstone: medium to coarse, fair sorted, siliceous cement.	8	73
Overburden	20	65
Stromatolitic dolomite: buff to red on weathered surface, purple, buff, red and pink on fresh surface, laminated massive and stromatolitic. Stromatolites are close linked hemispheroids up to 3 feet across and 3 feet high. Unusually high background radioactivity.	40	45

Section 3 (cont'd)

Rock Unit Description	Thickness in feet	
	Unit	Total
Stromatolitic dolomite (cont'd): Lower contact is gradational over 1 foot through sandy dolomite.		
Sandstone: purplish red, medium, well sorted, orthoquartzitic to subfeldspathic, contains minor coarse buff sandstone.	5	5
Paleoregolith: granitic rock completely and partially altered by sericitization, green and locally sheared.	10	
Slightly altered pink granite and granite gneiss, contains biotite and altered biotite, schleiren of biotite gneiss often bearing minor chalcopyrite, numerous shears and small faults.	20	
Lake		

Legend

100 Radiometric contours at 75, 100, 125, 150, 300, 600, 1000, 2000 and 5000 counts per second: measured at waist level with a SRAT SPP-2-NF scintillometer *(1·5×1 inch scintillator)*.

Contour uncertain due to overburden or blasting debris

⊙ Base or picket line station

△ Instrument set up (alidade)

□ Bench mark

Note: Contours based on 5 foot square grid readings for 100 counts per second and above. 75 counts per second contour based on 10 foot square grid readings

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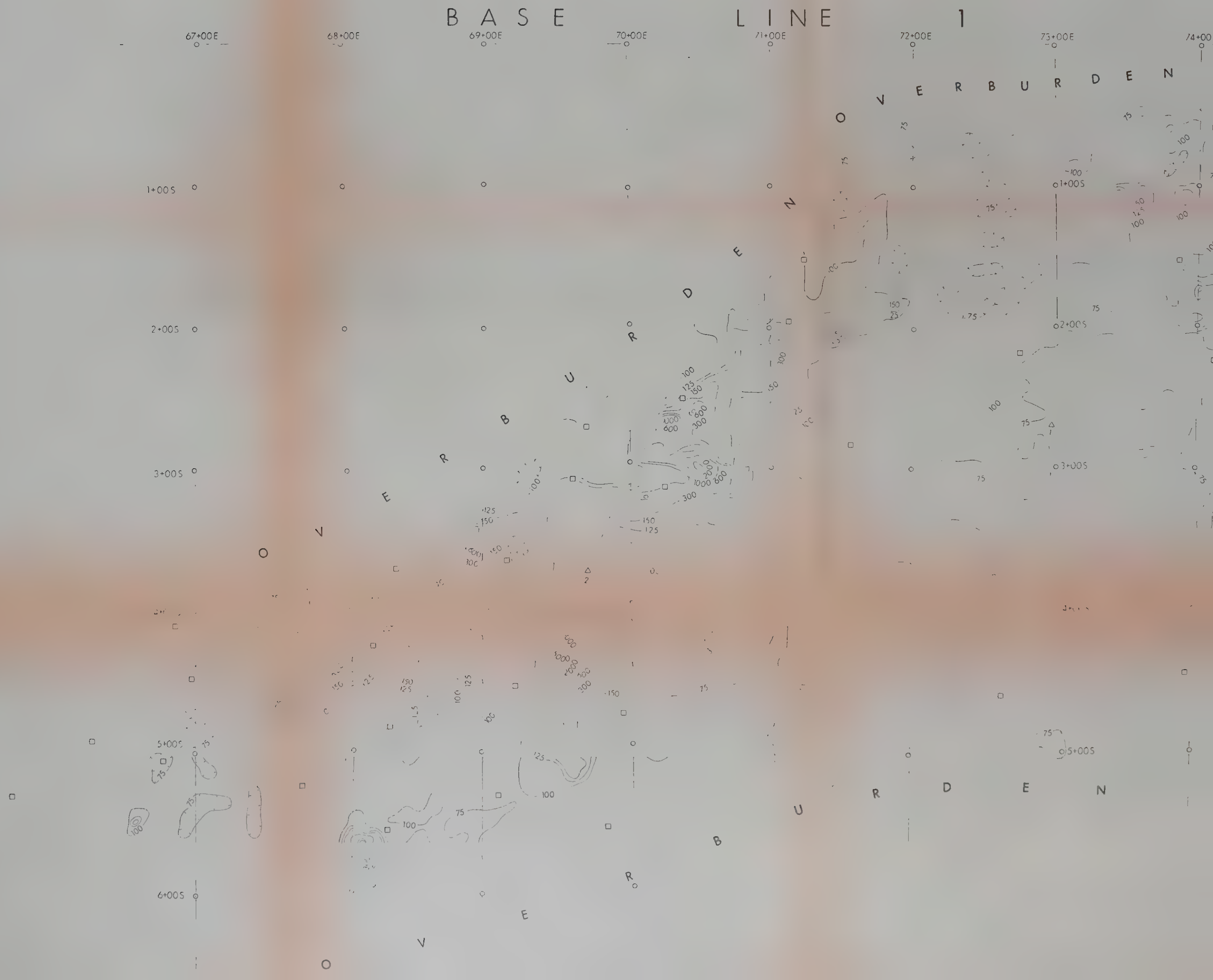

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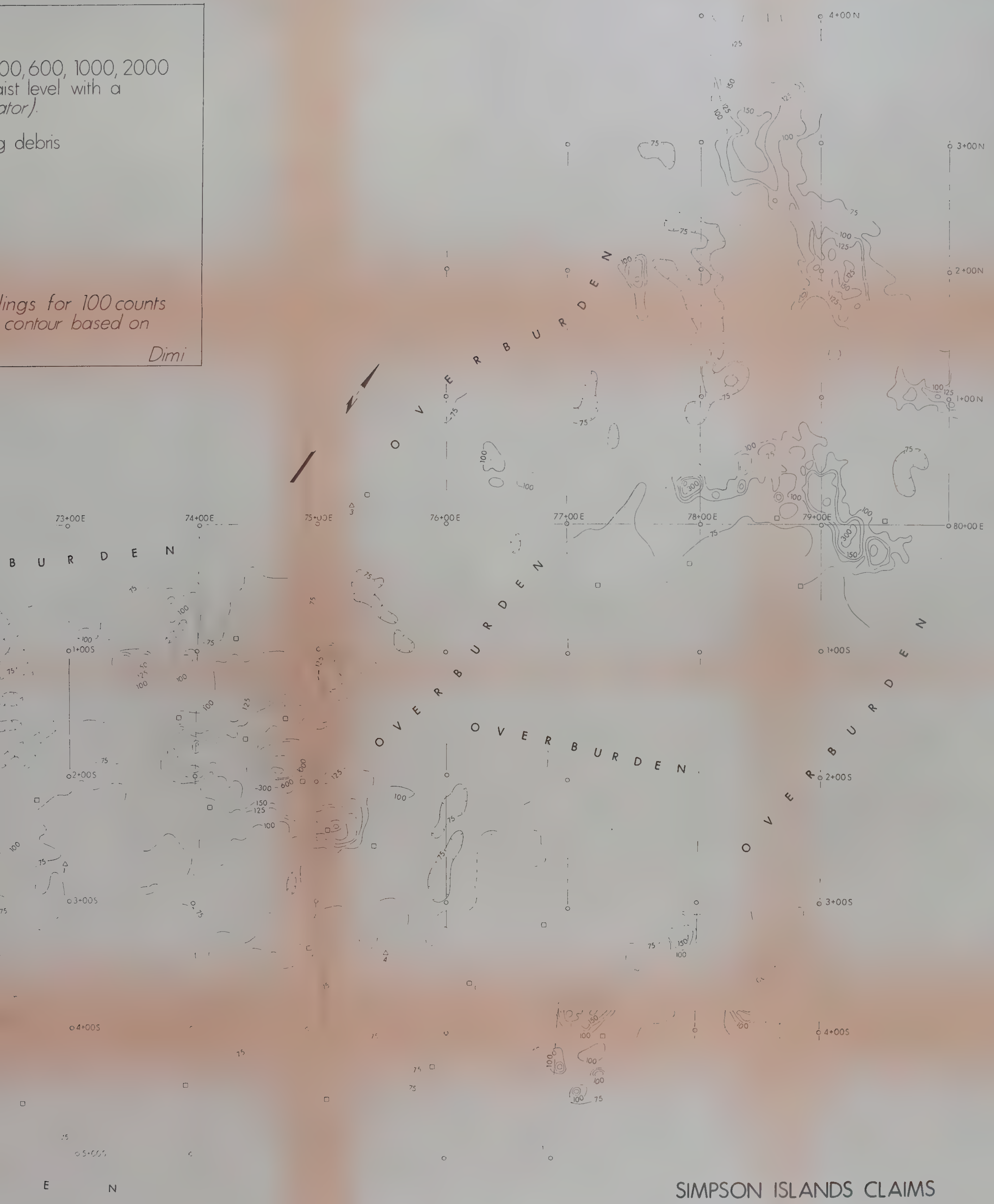

SIMPSON ISLANDS CLAIMS
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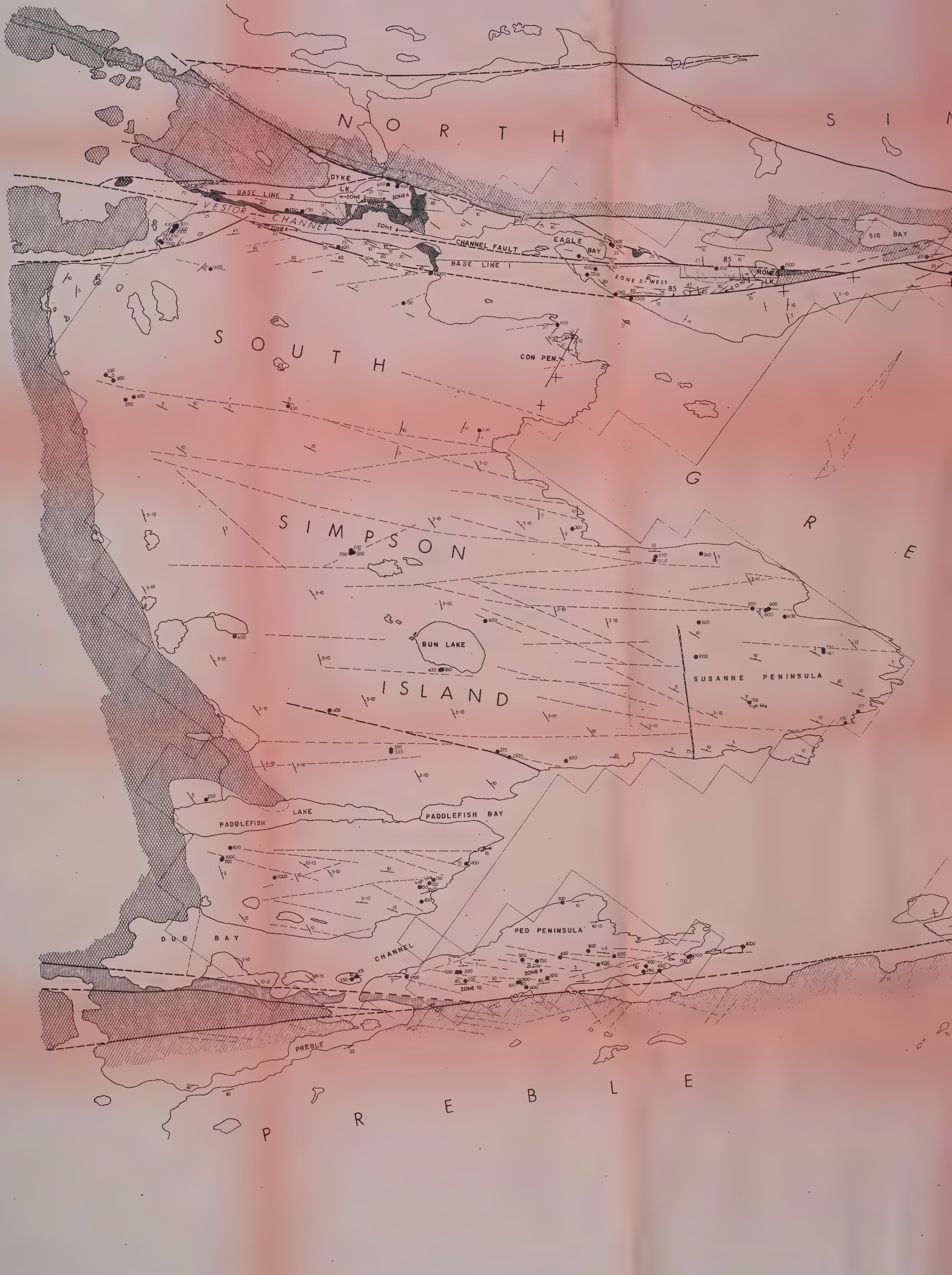
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ZONE 5
ROMEO LK.
SIG BAY
SOUTH
CON PEN.
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ISLAND
BUN LAKE
SUSANNE PENINSULA
high bkg
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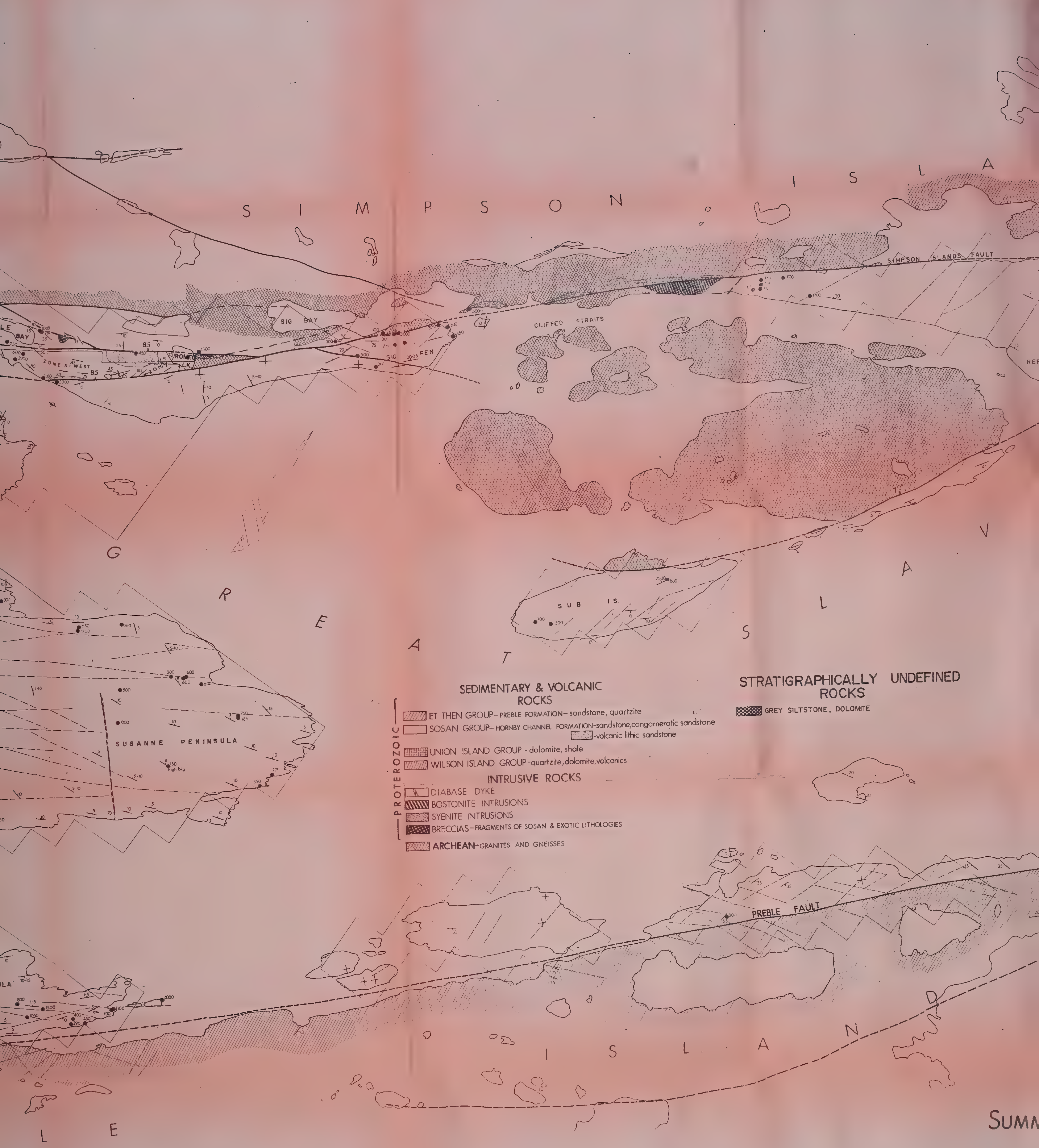
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SEDIMENTARY & VOLCANIC ROCKS
PROTEROZOIC
ET THEN GROUP–PREBLE FORMATION–sandstone, quartzite
SOSAN GROUP–HORNBY CHANNEL FORMATION-sandstone, congomeratic sandstone
-volcanic lithic sandstone
UNION ISLAND GROUP - dolomite, shale
WILSON ISLAND GROUP-quartzite, dolomite, volcanics
INTRUSIVE ROCKS
DIABASE DYKE
BOSTONITE INTRUSIONS
SYENITE INTRUSIONS
BRECCIAS–FRAGMENTS OF SOSAN & EXOTIC LITHOLOGIES
ARCHEAN-GRANITES AND GNEISSES
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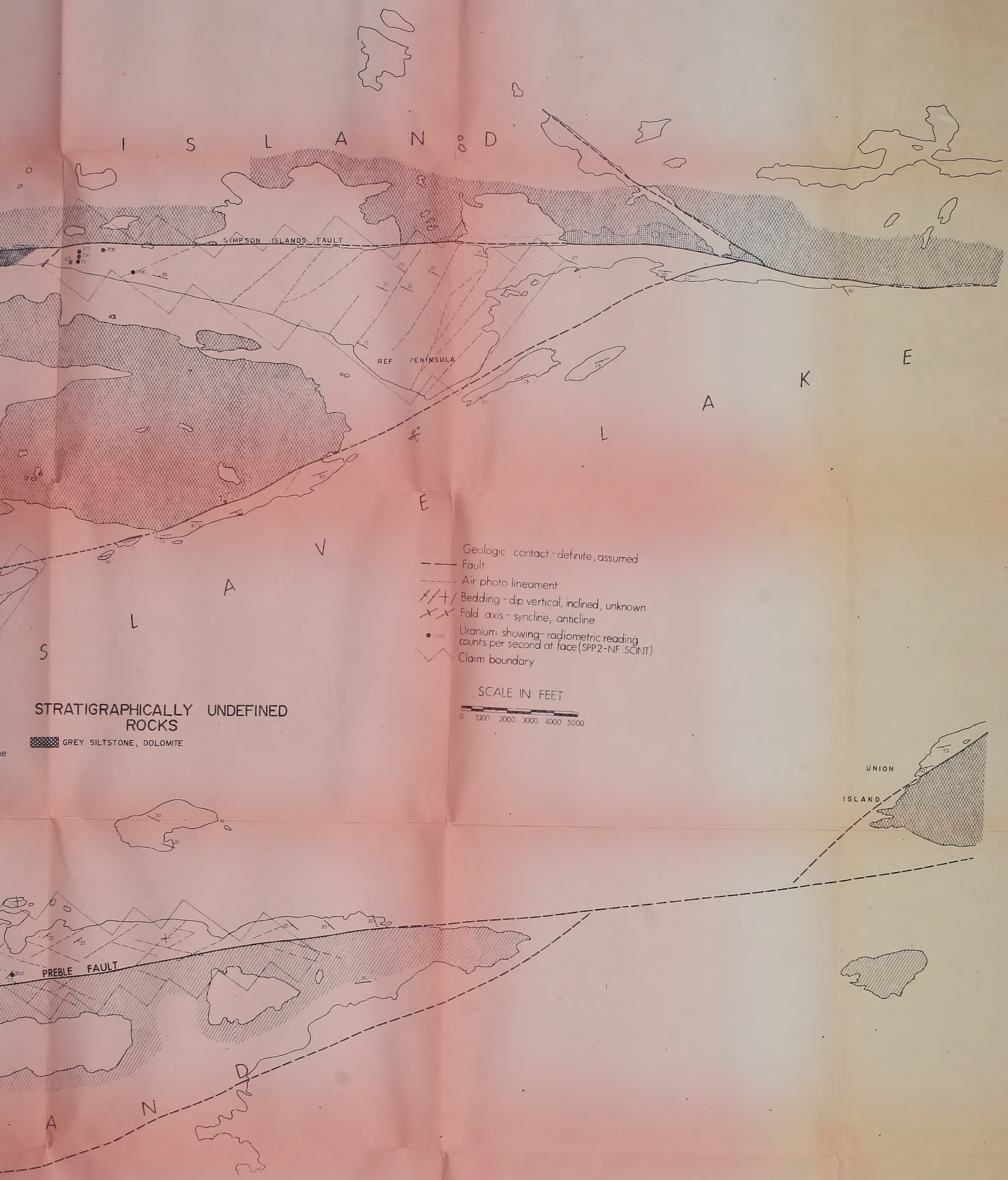
GREY SILTSTONE, DOLOMITE
SUMM


I S L A N D
SIMPSON ISLANDS FAULT
REF PENINSULA
S L A V E L A K E
Geologic contact - definite, assumed
Fault
Air photo lineament
Bedding - dip vertical, inclined, unknown
Fold axis - syncline, anticline
Uranium showing - radiometric reading counts per second at face (SPP2-NF SCINT)
Claim boundary
SCALE IN FEET
0 1000 2000 3000 4000 5000
STRATIGRAPHICALLY UNDEFINED ROCKS
GREY SILTSTONE, DOLOMITE
UNION ISLAND
PREBLE FAULT
A N D

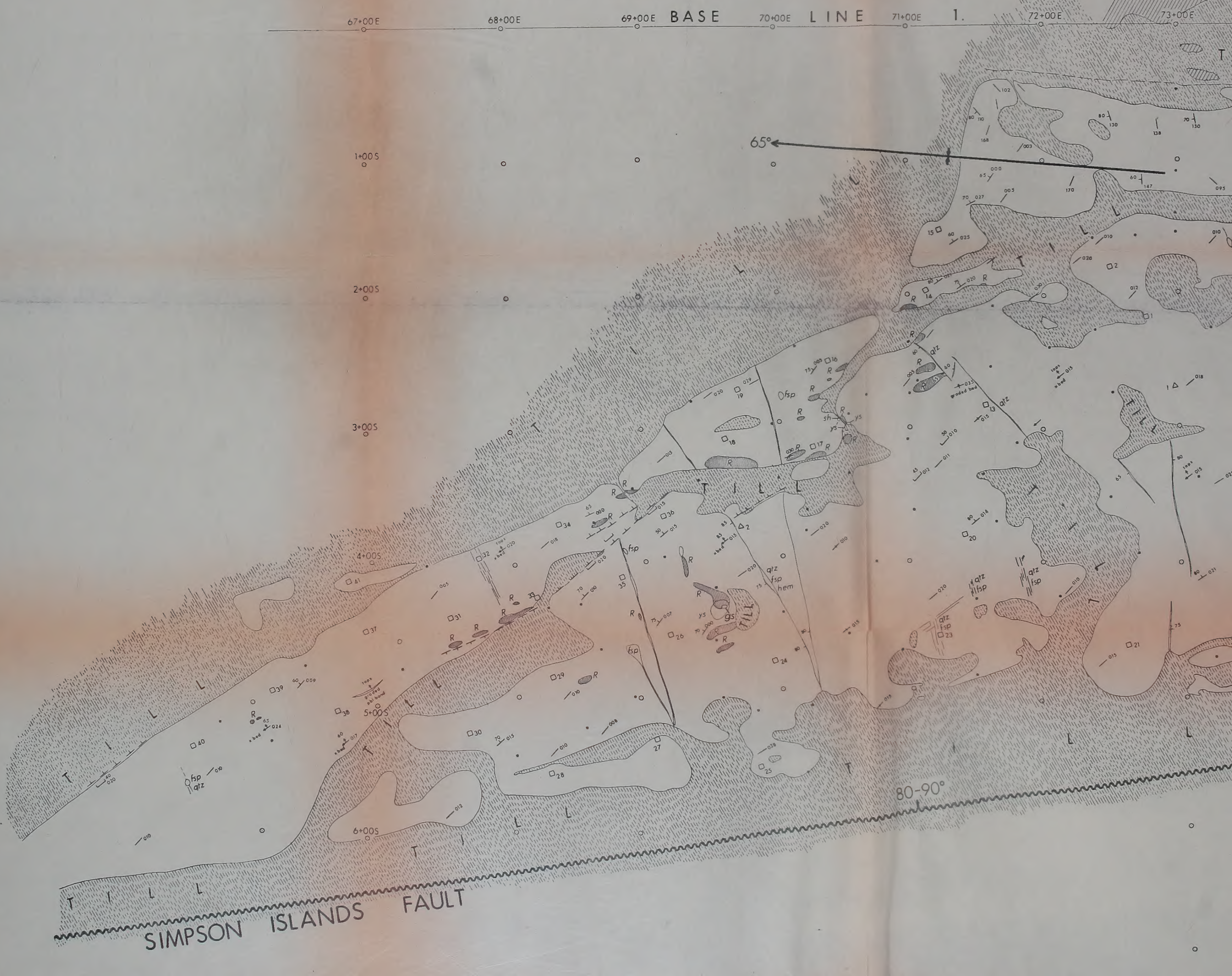
SUMMARY GEOLOGIC MAP OF SIMPSON ISLANDS CLAIMS

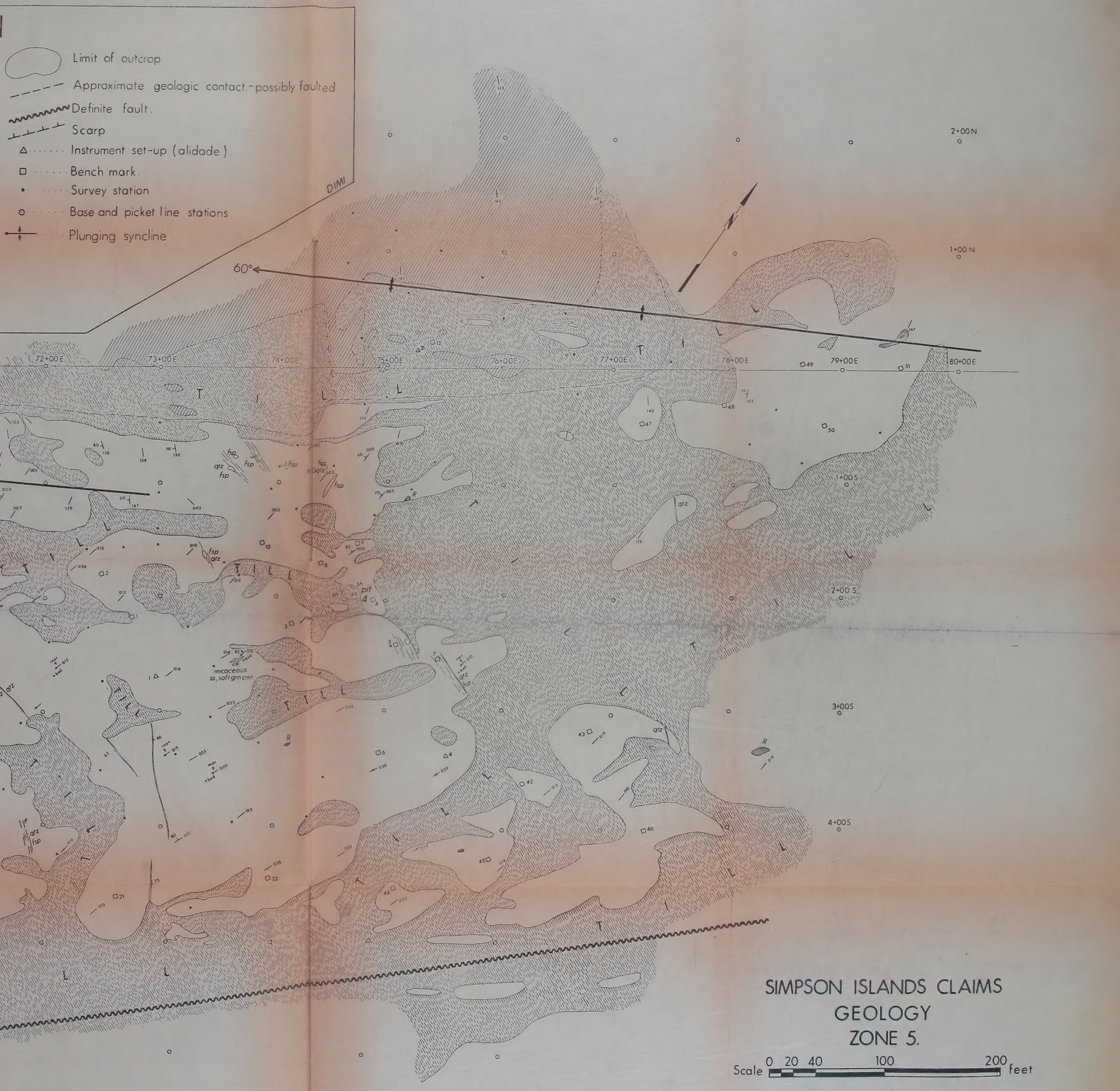
GREAT SLAVE LAKE, N.W.T.

L e g e n d

☐	Hornby Channel Fm; feldspathic to orthoquartzitic sandstone and conglomeratic sandstone. Siliceous to sericitic cement.
R	Rusty red hematite stained sandstone and conglomeratic sandstone.
▨	Chlorite cemented lithic sandstone containing volcanic rock fragments.
qtz fsp hem	Veins of quartz, quartz and feldspar or feldspar. Locally containing hematite
gs	Green secondary uranium mineralization
ys	Yellow secondary uranium mineralization
sh	Shale lens (tectonically deformed).
	Prominant joint
	Bedding orientation: inclined, vertical, dip unknown.
	Bedding orientation showing current direction and way up of beds with known and unknown dip.
x bed, pbl band	Cross bedding, pebble band

	Limit of outcrop.
	Approximate geologic co
	Definite fault.
	Scarp
△	Instrument set-up (alidad
□	Bench mark.
•	Survey station
○	Base and picket line statio
	Plunging syncline





SIMPSON ISLANDS CLAIMS
GEOLOGY
ZONE 5.

Scale 0 20 40 100 200 feet

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